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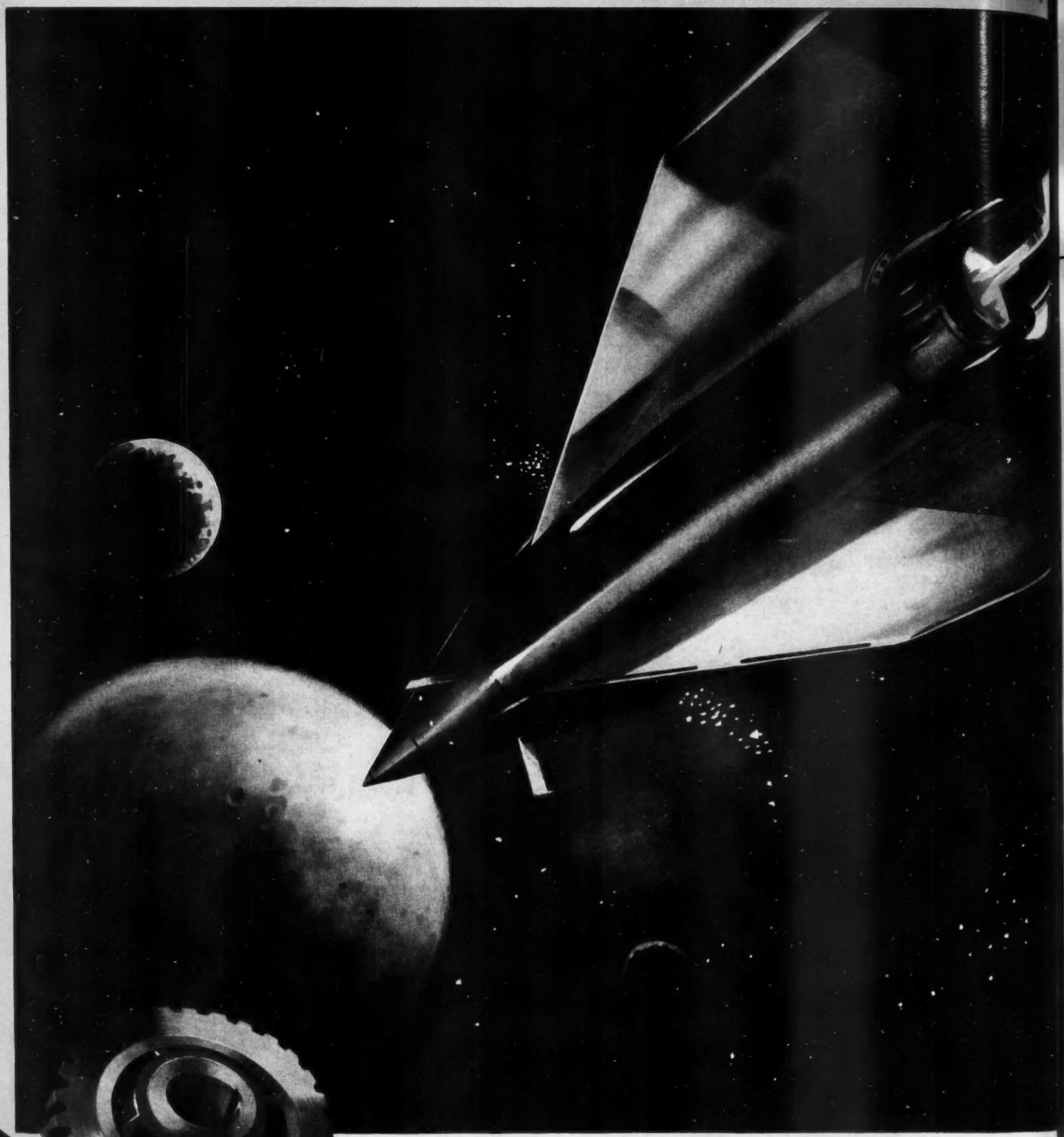

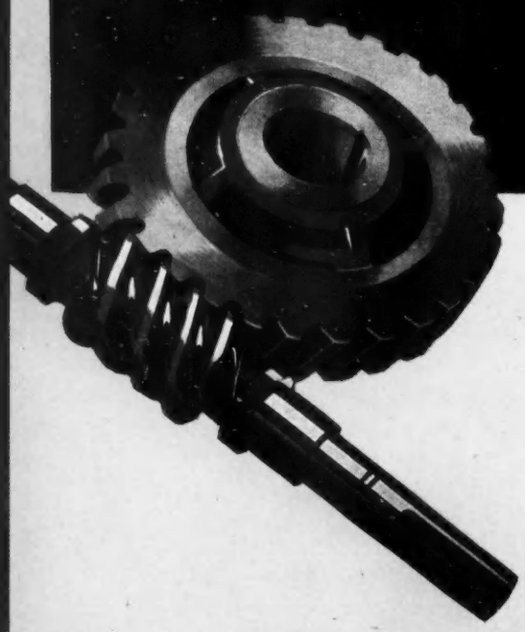

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PUBLISHED EVERY FRIDAY

Vol. 185 No. 4792 10 January 1958

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The New Babel

WHEN Childe Roland came to the dark tower—the tower of mystery and challenge—he would have been disarmed to discover that it had become a tower of Babel. Twentieth Century man, faced with the challenge of science and engineering, finds himself confronted with a confusion of scientific and technical languages. In science some progress can be made without intercommunication between specialities, but engineering, because it is the application of many sciences and not the pursuit of one, remains barren unless there is constant cross-fertilisation. The scientist isolates himself and burrows deep into his field of study only to emerge when his results assume sudden importance for the outside world. It is only at this point that the problem of communication becomes serious, for it is only then that the scientist's results begin to affect the lives of people generally. And it is also at this point that they become the concern of engineering. Again, engineering, which is the operation of producing goods for use, implies communication between maker and user. Important though the problem of intercommunication may be for science, for engineering it is vital.

There are two related approaches to the problem. The first is concerned with the languages themselves and the means available for learning them. Speaking before an audience of teachers last week, Professor B. Pattison, Professor of Education at London University, said that the time had come to reconsider the function of English. "Those who emerge from the hothouse atmosphere [of the classroom] are numbed by the fresh air of the outside world. Courses are not planned to teach the specific languages most likely to be needed in ordinary life. Unless the exercises in speech and writing are comparable to the problems later to be faced, they will not necessarily fit people to solve those problems." Professor Pattison's remarks apply particularly to the languages of engineering.

Feedback and backlash are words with a usefulness that extends far beyond the confines of technology, but they will be found in few standard dictionaries. Whereas law, for example, and botany are represented in abundance. We also find such terms of limited application and great obscurity as felibrist and babiroussa. It is almost as if there were a conspiracy of lexicographers determined that no vulgar technical word should soil the chaste pages of their works. Many technical words, banausic though they may be considered, would grace even the most literate vocabulary, enriching the idiom and providing a whole new world of metaphor. But whether or not such words and the writing of technical reports might usefully supplement the disciplines of normal education, they would certainly provide a valuable introduction to the technical languages so important in life to-day.

Unfortunately no one could hope to proceed very far by merely extending his vocabulary. As Mr. B. C. Brookes points out in an article in *Impulse*, communication depends to a great extent on shared experience. It is useless to discuss the colour green with a man who is colour-blind, or to talk of chopper circuits with someone not acquainted with electronics. In communication theory "set" may be understood as the state of a person's experience and beliefs with respect to a new situation or stimulus. Thus as Mr. Colin Cherry observes in his book *On Human Communication*, "the more prior relevant experience, the sharper the 'set' and the more ready the response." Clearly intercommunication presents serious problems since no one can possibly embrace all the relevant experience. Leibniz, it is said, was the last man to know everything.

This leads to the second approach. How can the training of engineers and scientists be adapted to the needs of intercommunication? How can their experience be extended to bring about a fruitful interplay between the many branches of science and engineering? Broadly, there are at present two kinds of training: there are courses based on a narrow specialisation, and courses in which an attempt is made to provide a foundation over a wide area. Neither provides the deep familiarity with several specialities likely to be most rewarding. In addition to these, therefore, it might be profitable to institute a comparatively small number of university courses in which two specialist fields are treated in some detail. They might be as disparate as electronics and biology, and work in both should if possible be continued when the graduate enters industry. If the humanities—a taste for which can be acquired by most men in their leisure—are considered a profitable addition to an engineering course, how much more valuable to a civil engineer would be a knowledge of geology or Russian?

Specialisation has tended to destroy cohesion in engineering work but the systematic study of communication may help to restore it. The use of bi-specialists to knit together the corpus of engineering knowledge may bear unexpected fruit.

Cover Picture. *The cage halves of single-row ball bearings are seen being assembled on a fixture which is then indexed to present the assembly under the working head of a rivet-inserting machine. The very small rivets are fed from a hopper and automatically inserted in the cage rivet holes. The operator finally transfers the assembly to the loading chute of a pneumatic press which carries out automatically the rivet closing operation.*

* * *

Plain Words

A journalistic exercise which is popular in Britain twice a year is a little good-humoured criticism of the selection of names for the Honours List. It usually takes the form of asking a rhetorical question as to why such-and-such a famous batsman has been made a C.B.E. and not knighted. A variation of the game consists in expressing surprise on reading that so-and-so, the man who invented what's it more than thirty years ago, has only now had his work publicly recognised.

I am guilty of yet another exercise. Taking all honours and awards down to membership of orders, I have analysed this year's list in a simple but informative way. There were about a thousand awards, if we exclude (for simplicity in analysis) those to persons overseas. The greatest number still go to persons in Government service—as would be expected. A total of 580 awards went to such people (apart from recipients employed in work of an engineering nature, whom I mention later). The only 2 new peers are in this category, as well as 287 new " members " of orders, 141 officers, 119 companions and 10 knights bachelor. It is right that men and women who serve their country in this way should be so well represented in the list.

" Political and social services " and similar attributions cover a wide range of activities. The total there was 247, distributed over most of the honours which can be bestowed. Recipients of honours who are engaged in engineering work of one kind or another, whether in State service or in industry, did very well; there were 86 of them, compared with only 54 in all other industries, though this comparison is probably no more than a reflection of the fact that the engineering industries now constitute the biggest slice of industry and commerce in the country. The honours awarded to people in this category ranged from 49 members of orders to 3 knights bachelor. The last of my selected categories is " education "; here there was a total of 35, which does not seem many for a profession which holds the key to so much of our future well-being and success.

If honours go to men and women who perform services which are beyond the normal range of their duties—as indeed they do—then there are few people to-day who are precluded by the nature of their work. More than ever in our history, we are servants of each other. It may be hard to-day to start a new business—though some still manage it—but there are countless opportunities for men to give of their best.

CAPRICORN

Weekly Survey

What the Steel Makers are Saying

Steel deliveries for 1957 may not be a very accurate guide for 1958 but the trading results of the Lancashire Steel Corporation Limited and the sobering remarks of Mr. A. G. Stewart, chairman and general managing director of Stewarts and Lloyds Limited, in his annual review, provided a cautionary tale for the optimists who still favour bounding expansion for the steel industry.

A certain flavour of circumspection can also be seen in the British Iron and Steel Federation's estimate of output for this year, which is discussed in *Steel Review*. The Federation expect the industry to produce rather more steel than the estimated output in 1957, an output which is likely to have been about 21·8 million tons, but they do not expect complete use of available capacity, which is put at 23·5 million tons. They foresee that the credit squeeze will continue to affect adversely the trend of investment and therefore the rate of expansion of steel deliveries in the home market, but they hope that this will be counterbalanced by expanding exports. Optimism about exports is qualified by the expectation of increased competition.

Caution, however, is not likely to affect seriously the industry's attitude to its development plans. The development scheme is to continue and plans for this year include a further 107 coke ovens, sinter plant, 3 blast furnaces, 2 open hearth furnaces and 3 Bessemer converters. There is some irony in the fact that the iron and steel industry, which has been continuously criticised for a cautious attitude towards investment and which has only recently become a convert to the idea of a Free Trade Area, is facing the advent of the European Economic Community and the potential Free Trade Area with a continuing investment plan, while the engineering industry, many sections of which have seen clear advantages in closer European economic co-operation for some time, is forced to review its investment plans in the light of high interest rates and postponed investment by some of its bigger customers.

Mr. Tube

In a fighting address to the shareholders, Mr. A. G. Stewart, chairman and general managing director of Stewarts and Lloyds, announces his board's decision " to fight the issue of nationalisation." It is their view that nationalisation would damage the company and they therefore intend to take whatever action may be needed to protect their interests. If it is necessary to become involved in politics that " just cannot be helped." The board are seeking the shareholders' authority to take any action they think necessary, including presumably the spending of company funds, in the carrying out of a campaign against the nationalisation of the industry. There have been rumours for some time now that the boards of the steel companies may begin an active campaign—as an industry—and Mr. Stewart's announcement may only be the first of many. The other steel chairmen's speeches are due in rapid succession over the next few weeks.

The damage being done to the industry's prospects by the threat of re-nationalisation lies principally in its financial operations. It hinders the raising of new capital and most companies, including Stewarts and Lloyds, have commitments on capital account which cannot possibly be met out of retained profits and depreciation. Yet the figures announced by Stewarts and Lloyds are evidence of a splendid performance in the financial year ended at September 29. The group's trading profits amounted to £18·25 million, representing an increase of £1·73 million on the previous year. Next year, however, is unlikely to be so good. There was a 15 per cent. drop in the sale of general purpose tubes in sizes up to 4 in. diameter sold on the home market. The Government's financial restrictions have accentuated this trend and demand is expected to fall further during the current year. The principal gains, of over 20 per cent. in sales to the oil industry and 15 per cent. in the direct exports of other types of tube, are unlikely to be repeated. Mr. Stewart said that " towards the end of the year" it became evident that the oil industry's requirements throughout the world were being satisfied." Some increase in demand from this source is expected, however, and the company are going ahead with plans to expand their capacity.

In the longer term prospects Mr. Stewart has confidence. Demand will continue to grow. For the next year or two, however, prospects are uncertain; demand is likely to be downward, and vitally affected by the behaviour of international trade.

European Steel

Steel production in Europe continued at a high level in the third quarter of 1957. The Economic Commission for Europe *Quarterly Bulletin of Steel Statistics* shows that, compared with a year ago, the main steel producers scored big percentage increases. Output in Western Germany went up by 5 per cent., United Kingdom 6 per cent., France 5 per cent., Italy 15 per cent., Luxembourg 2 per cent., Saar 3 per cent., and Netherlands 15 per cent. Only Belgium, where there was a steel strike throughout July, showed a decrease.

More than half the steel entering into world trade now comes from the European Coal and Steel Community. Imports of iron and steel have always been on a small scale and limited to a number of special products. Community steel exports to the rest of the world in 1957 were approximately twice those of the United States and three times those of Britain. The Community's biggest single customer for steel was the United States which during the first quarter of 1957 took an average of 114,580 tons a month. Britain was the second biggest European customer for Community steel with an average of 68,500 tons a month.

Coal and Steel Trading

The discussion by G.A.T.T. (General Agreement on Tariffs and Trade) of the Rome Treaty setting up the European Common Market has attracted so much attention that its examination of the affairs of the European Coal and Steel Community has almost escaped notice. E.C.S.C. with the same six members is in many ways a pilot scheme for the Common Market. G.A.T.T. comes into the picture because in 1952 the six E.C.S.C. members asked for a waiver from some of their obligations under G.A.T.T., in particular the most-favoured-nation clause, and the rule of non-discrimination on the application of quantitative restrictions. As a condition of granting this waiver G.A.T.T. receives an annual report, which is discussed by a working party which includes countries outside the E.C.S.C. The most interesting parts of its report are those raised by countries more or less dependent on the Community for their coal, coke and steel. Sweden, for example, was anxious about the supply of scrap, exports of which are at present restricted. The representative of the High Authority hoped that the policy of increasing the ratio of pig iron to scrap would ease the position but this will clearly be a fairly long-term solution. Both Denmark and Sweden complained that export prices for coal and coke were above internal prices. The suggestion here was that, particularly for coke, the Community

was taking undue advantage of the world shortage of coking coal.

It was admitted that Germany, the main coke exporter, maintained " substantial " price differences. Indian and Czech representatives complained that they had been charged higher prices for Community steel than by other countries. The difficulty of deciding what " extras " applied in each case blanketed discussion of this complaint. The Czechs claimed, however, that their exporters got lower prices for steel sold to the Community than their importers had to pay in buying comparable Community steel. The size of the Community's output makes it a price leader in the world steel market. The Danes complained that steel exporters had introduced quotas without any reference to the High Authority. The fact that export prices are fixed by the Brussels Convention places third countries at a disadvantage. So far the High Authority has been unable to do anything about this except make occasional appeals for restraint. But apart from these various complaints the working party concluded that the provisions of the Treaty had been carried out and a Common Market in coal and steel established.

It was clear, however, that a number of countries trading with the Six felt that the Common Market was not only in the interests of its members but against those of third countries. This sort of public examination of the operation of the Coal and Steel Community is extremely valuable. No doubt G.A.T.T. will find this experience useful when it comes to discuss the Common Market next year.

Community's Small Neighbours

On the map Austria and Switzerland are in the centre of the European Coal and Steel Community. Neither belongs to it. Every year 868,000 metric tons of coal, 710,000 tons of scrap and 230,000 tons of steel pass through Austria and Switzerland on their way from Germany and Benelux to Italy. Both countries depend on the Community for most of their solid-fuel imports. Both would probably have joined the Community long since except for the difficulties this would have raised over political neutrality. As this is out of the question, special arrangements have been made to cover their relations with the Community. Switzerland has had a mission at Luxembourg since 1953. An agreement signed in 1956 provides for two-way talks before action is taken that will affect the other's economic interests. Much Swiss money has found its way into Community industries. A 50 million Swiss franc 18-year loan floated in 1956 was heavily over-subscribed. Austria's formal relations with the Community are on the basis of Austrian membership of G.A.T.T. Apart from this there have been agreements on research and industrial medicine. Most important, however, from the Community point of view, both Austria and Switzerland have signed transport agreements abolishing the " break in rates " for coal and steel in transit across their territories. As a result, tapering freight rates are now possible from Belgium right down into Italy.

Europe's Economy Under Review

The *Economic Bulletin for Europe*, just published by the Economic Commission for Europe (E.C.E.) puts the problems of the day into perspective. For Western Europe as a whole the slowing down in the rate of growth of industrial production went on during the third quarter of 1957. There were signs of a fall in demand for producer goods largely because of the slowing down of investment and reduced export demand for steel. But experience varied from industry to industry. Expanding production and export of motor vehicles, especially to the United States market and the backlog of shipping orders, are both contrary to the general trend. Except in France and Finland wholesale prices have tended to level off and even to fall, while retail price increases have generally been less than 2 per cent., except in Holland and Ireland. In most countries wage increases have not outpaced industrial production. Trade between European countries reached an all-time record in the nine months up to September. The United Kingdom balance of payments position is seen as likely to remain sensitive while the reserves are vulnerable to short-term capital movement.

The principal cause for alarm, according to the experts, is the beginning of a recession in the United States. But they point out that with the present low level of consumer's stocks, especially in non-ferrous metals, even a small revival of consumption could lead to a recovery in prices.

The necessity for the 7 per cent. Bank Rate and the rest of the Government's policies is not questioned. Nevertheless, the experts believe that such restrictive measures may lead to a " stagnation of investment." The success of the measures in relieving wage-induced inflation depends on the reactions of the trade unions to changes in the level of activity. The two factors most likely to improve the economic situation of Western Europe are a resumption of activity in the United States and a renewal of expansion in Germany with increased imports. For Eastern Europe scarcities of fuel and electric power remain the principal restraints on the rate of growth of output. On the whole the report is reasonably optimistic with the prospect of an American recession as the big question mark in the background.

Soviet Planning in Central Asia

An article on economic policy in Soviet Central Asia in the current issue of the Economic Commission for Europe *Economic Bulletin for Europe* examines the development of Soviet economic planning in the four central Asian republics of Uzbekistan, Kirgizia, Tadzhikistan and Turkmenia. The region was occupied by Russia nearly a century ago, and cotton growing dates from that time. Since 1917 agriculture has been concentrated entirely on cotton and output has quintupled. The irrigated area has been increased by such works as the Main Fergana Canal and the cotton crop has been given practically the whole of the region's fertiliser supply. Farm collectivisation has been general and a premium system to raise yields has been widely used. Industry in the region has concentrated on producing consumer goods for the local market. This means that Central Asia depends on other parts of the U.S.S.R. for its grain, capital goods and some consumer durables. The ratio of the price of cotton to that of goods brought in from elsewhere gives central Asia favourable terms of trade in buying steel but puts it at a disadvantage in wheat compared with world prices. The increased production of man-made fibres may seriously affect cotton prices and cropping plans. The region is short of capital and further industrialisation will depend on increasing investment from the rest of the U.S.S.R.

Personal consumption in Central Asia is from one-fifth to one-quarter below that of the Soviet Union as a whole, but is higher than in neighbouring Asian countries. The average farmer in the region is better off than his counterpart in the rest of the country, but poorer than a town dweller. Improvement of transport facilities will be an important factor in lessening the isolation of the region. From Czarist times railways in this part of Asia have, for strategic reasons, run east-west, never north-south. The report foresees a rapid linking up with the Persian Gulf by way of Iran and with the Indian Ocean through Afghanistan and Pakistan as an immediate consequence of any future change in the political climate. Such a development would have tremendous importance for the economy of the whole of western and central Asia.

Letters to the Editor

MR. FOX AT THE DRAWING BOARD

SIR, The note on the centenary of the firm of Freeman, Fox and Partners in ENGINEERING of January 3 reminded me of a contemporary account—which I possess—of the construction of the Great Exhibition Building in Hyde Park, which was completed in the astonishingly short time of about six months. This account reports a speech made by the senior partner of the firm of Fox and Henderson, the main contractors, at a dinner given in his honour by his fellow citizens of Derby. In the course of Mr. Fox's 3,000-word speech, he says that, after having persuaded the committee to appoint one senior man with whom he could deal direct in all constructional matters:—

> " It was now that I commenced the laborious work of deciding upon the proportions and strengths required in every part of this great and novel structure, so as to ensure that perfect safety essential in a building destined to receive millions of human beings—one entirely without precedent, and where mistakes might have led to the most serious disasters. Having satisfied myself on these necessary points, I set to work and made every important drawing of the building, as it now stands, with my own hand, and it was no small source of gratification to me, when asking Mr. Cubitt (the committee man) to look over the drawings I had prepared, to find that he not only had no desire to suggest alterations, but expressed entire approval of them all."

They took possession of the site in Hyde Park on July 30, and started to lay out the various parts of the building. Continuing his speech:—

> " The drawings occupied me about eighteen hours each day for about seven weeks, and as they went from my hand Mr. Henderson prepared the ironwork and other materials required in the construction of the building. As the drawings proceeded the calculations of strength were made, and as soon as a number of the important parts were prepared, such as the cast iron girders and wrought iron trusses, we invited Mr. Cubitt to pay us a visit to our works at Birmingham to witness a set of experiments in proof of the correctness of these calculations."

These trials were done on September 6; four times the design load was needed before fracture. Work was pushed on rapidly and the first column was erected in its place on September 26.

It is, of course, quite impossible nowadays for the senior partner of a large contracting firm to spend eighteen hours a day on his own drawing board for seven weeks, but this story does give an idea of the importance of proper attention to the detail drawings, at a sufficiently high level, if success is to be ensured, and inordinate delay in production avoided, especially with material of any novelty. The principle involved is still valid to-day for atomic power stations, etc.

Yours truly,
HUGH CLAUSEN.

London, N.W.2.
January 3, 1958.

Editor's Note: In the note referred to above it was reported that the late Sir Ralph Freeman joined the firm in 1911. Mr. Freeman, as he then was, in fact joined the firm in 1901 as a graduate-assistant at the age of 20; he became a partner in 1912.

OIL IN SICILY

SIR, In the note " Sicily Sets the Pace " on page 777 of your December 20 issue, you made the following statement: " Gulf-Oil working on an 80/20 split, perhaps the best terms ever offered an oil company, has invested 50 million dols. in Sicily's oil field and is getting results that make the efforts of ENI the State-owned corporation on the mainland look pretty weak."

The truth is that the Gulf Italia Company under its concession terms pays to the Sicilian

Continuing Letters to the Editor

Government a royalty of one-eighth of gross production, plus corporate taxes (i.e., income tax and tax on capital and profit). The combined and aggregate payment of royalty and taxes to the Government results in what is virtually equivalent to a 50/50 split of profits.

Yours faithfully,

A. GREGERSEN.

Gulf Eastern Company,
4 Stanhope Gate,
London, W.1.
December 31, 1957.

★ ★ ★

Obituary

SIR ALLIOTT VERDON-ROE

Aircraft Designer and Pilot

Probably the foremost of the British aviation pioneers was Sir Alliott Verdon-Roe, who died in hospital on Saturday, January 4. Founder of A. V. Roe and Company Limited, and for many years president of Saunders-Roe Limited, Sir Alliott was the first Englishman ever to leave the ground in a powered aircraft of his own design and construction, although the short hops that he made in 1908 were not of sufficient duration to secure for him recognition as Britain's first pilot—a distinction credited to Lord Brabazon of Tara.

Sir Alliott Verdon-Roe was born in 1877 and was educated at St. Paul's School, on leaving which he was apprenticed to the Lancashire and Yorkshire Railway Locomotive Works, and until 1905 he was working on locomotive and marine engineering. His interest turned to aeronautics and from 1906 he concentrated on this field. The biplane aircraft in which he made the first "hops" from Brooklands in 1908 was a full-size version of the prize-winning model in the 1907 *Daily Mail* model aeroplane competition, and was powered by a 24 h.p. Antoinette engine.

Roe was the pioneer of the tractor type of aircraft, the first of which was the triplane which he constructed and flew in 1909. The most famous of these was the outstandingly successful and long-lived 504 series of biplanes, which played an important part in the 1914-1918 war and in which subsequently very many people not yet born in 1912, when the first of the 504's was designed, have been initiated to flight.

Also pioneered by Roe was the design and construction of seaplanes in the United Kingdom, and the construction in 1912 of the first cabin aeroplane in the world. The Avro company he formed in 1910, with his brother, the late Humphrey Verdon-Roe. He sold his interest in Avro in 1928 and acquired an interest in the flying-boat builders, S. E. Saunders Limited, of Cowes, which subsequently became Saunders-Roe Limited. In addition to being president of the latter firm, he was also for some years chairman of Aviation Developments Limited, makers of the Chobert and Avdel blind-riveting systems so widely used in aircraft manufacture.

Sir Alliott was created a knight in 1929; he was a fellow of the Institute of Aeronautical Sciences and an honorary fellow of the Royal Aeronautical Society.

VISCOUNT WAVERLEY

With the death of Lord Waverley there has gone one of the very few who, trained basically in the sciences, have reached the highest offices in either the civil service or the government. Lord Waverley—almost uniquely—achieved both. He secured senior posts in the executive both at home and abroad as well as holding principal portfolios in the Government. Since leaving the Cabinet he had been a distinguished chairman of the Port of London Authority, served on many government committees and sat on the boards of several public companies. To complete the compass there was also his extensive patronage of the arts. In particular, as president of the Royal Opera House, Covent Garden, he did much to encourage the revival of the ballet in this country after the war.

John Anderson was born at Eskbank, Midlothian, in 1882. His general education was obtained at George Watson's College, Edinburgh, and he later took his degree at the University there before going on to Leipzig University, his subject being chemistry. In 1905 he entered the civil service. His career in this respect culminated with his appointment as Permanent Under-Secretary of State at the Home Office. Then, in 1932, he became Governor of Bengal; after completion of his five-year term of office, he entered the House as M.P. for the Scottish Universities. Though no public speaker he quickly reached the front bench, his interests concentrating on civil defence; in particular, the provision of shelters and respirators became his concern and it was he who gave his name to the Anderson shelter that was later to be built in so many back gardens. As Chancellor of the Exchequer—in his civil service days he had been chairman of the Board of Inland Revenue—he introduced P.A.Y.E.

After the war, he was (among very many other duties) chairman of the advisory committee on atomic energy from 1945 to 1948. Also of particular interest to engineers was his chairmanship of the departmental committee on coastal flooding set up after the extensive damage done to the East Anglian coastline in January, 1953. This committee proposed and urged the serious consideration of a barrier, with "gates," across the Thames between Purfleet and Greenhithe as a protection for the Port of London and the higher reaches of the river against extraordinarily high tides.

His honours were many. He was created a K.C.B. as long ago as 1919 and other distinctions, of superior rank, followed until he received a viscountcy in 1952. His most recent honour—the O.M.—was bestowed only a few weeks ago while he was in hospital. Neither his personality nor his public speaking was of the kind that makes for popularity in a public figure but, with a scientific background, he was one of the most able successful administrators this country has yet produced.

MR. W. W. FRANKLIN

With the sudden death of Mr. William Walter Franklin, which occurred at his home at Ashford-in-the-Water, Derbyshire, on December 18, 1957, the country has lost its leading rolling-mill engineer.

Mr. Franklin, who was 57 years of age, was technical director of Davy and United Engineering Company, Limited, Park Iron Works, Sheffield, 4, and apart from service in the Royal Navy during the war of 1914-18, spent his entire career with the company. He served his apprenticeship with the firm and in 1931 took charge of the estimating drawing office, later becoming rolling-mill department manager and proposal manager. In July, 1947, he became chief engineer of Davy-United and in December, 1951, was appointed the company's technical director.

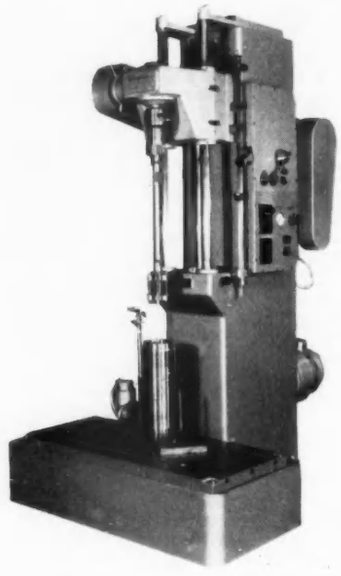
Mr. Franklin had established a reputation as a leading rolling-mill engineer, particularly in the field of section rolling. He was well-known to steelworks engineers and most of the large plants installed by his firm in this country under the steel industry's post-war development schemes were designed and carried through under his direct supervision.

He first joined the Institution of Mechanical Engineers as a student in 1923 and was finally transferred to the class of member in 1947. He was also a member of the Iron and Steel Institute, the Institute of Metals, the Sheffield Society of Engineers and Metallurgists and the Association of Iron and Steel Engineers of America. He also served on the Rolling-Mill Plant Committee of the British Iron and Steel Research Association.

Plant and Equipment

VERTICAL HONING

Introduced by Delapena and Son, Limited, Zona Works, Russell-place, Cheltenham, the vertical honing machine shown in the accompanying illustration has a diameter range of from 1·5 in. to 8 in. It will hone bores up to 24 in. long, a hydraulic stroke of 30 in. allowing the head to be lifted out of the bore. The work-table is



Semi-skilled operation is possible with this Delapena vertical honing machine, of 8 in. diameter and 24 in. bore length maximum capacity.

37 in. by 19 in., and the throat dimension 9½ in. A 5 h.p. electric motor drives the spindle and one of 2 h.p. provides the power for the hydraulic pump. In addition, there is a motor of ½ h.p. for the stone expansion and one of $\frac{1}{10}$ h.p. for honing coolant circulation. Controls are as simple as possible, thus making the machine suitable for semi-skilled operation.

DAMPER CONTROLS

For controlling the dampers and the boilers at the Goldington power station, Lockheed Industrial Hydraulics Division of the Automotive Products Company Limited, Speke, Liverpool, 19, have installed a system embodying electro-hydraulic controls. In brief, the equipment affords a press button control of the boiler dampers from a mimic diagram mounted on the boiler control panel. Damper indicators are included on this panel, the position of which corresponds to the position of the dampers themselves. Adjacent to each indicator is a pair of push buttons for opening and closing the dampers. A separate control cabinet, located in a convenient position, houses the hydraulic and electrical units. At Goldington the indicators take the form of coloured strips which turn through 90 deg. in relation to the ducts on the diagram.

In the event of failure of the remote control system or of the circuit supply, the dampers can be operated by hydraulic power direct from the cabinet. A hand-pump can be used to provide the operating fluid pressure if necessary. A restrictor unit is incorporated in the line leading to the full area end of the damper-operating cylinder, and has adjustment screws for controlling the rate of movement in both directions.

MOBILE CRANE

The most recent addition to the range of Jones cranes made by K & L Steelfounders and Engineers Limited, Letchworth (one of the 600 Group), is the KL10-6 which was recently demonstrated. It has been introduced as a companion to the KL10-10 in response to the continued demand for cranes of 10 tons capacity. The wheeled version is shown in the accompanying illustration.

Power is supplied from a Perkins Diesel engine developing 35½ h.p. at 1,500 r.p.m. (1 hour rating). This drives all four crane motions through a three-speed gearbox and triplex chain, there being separate dry-plate clutches for each motion. Unit construction is followed as far as possible and each motion mechanism is arranged in the form of a separate self-contained unit with all gearing totally enclosed. Servicing can thus be carried out by unit replacement, and as far as possible standard parts have been used both within the mechanism of one machine and between models.

The standard model has a lattice jib 30 ft. long. To this can be added up to four 10 ft. lengths to give a maximum working length of 70 ft. When used free-on-wheels the safe working load on the 30 ft. jib is 6 tons at 10 ft. radius; this is increased to 10 tons at 10 ft. if the outrigger jacks are used. With the 70 ft. jib the safe load is 3 tons at 17 ft. 7 in. Hoisting speed with a single fall of rope is 120 ft. per min. When there is need for special control of lowering speeds a governor mechanism can be fitted or alternatively an auxiliary drive from the engine can be used.

On the wheeled version, the pneumatic tyred wheels are fitted with restrictors that afford protection to the tyre walls and obviate all risk of tipping in the event of a blowout. The drive to the wheels is through a four-wheel differential which eliminates wheel spin and gives the crane a performance almost equal to that of a track vehicle on soft ground. The steering is progressively power assisted and has an automatic correction mechanism to allow for the position of the superstructure. In the standard model two-wheel steering is used, but where extra manœuvrability is necessary, all four wheels can be steered. In the first case the minimum turning radius is 24 ft. measured over the outside wheels.

A wide range of additional equipment is available, including a cab heater, electric lighting, audible and visible overload alarms and a tyre inflator driven from the engine. As alternatives to the hook, grabs up to 34/27 cub. ft. capacity or magnets up to 40 in. diameter can be fitted. Models include the wheeled version already mentioned, rail mounted models for most gauges and an edition mounted on a four-wheel-drive six-wheel chassis capable of speeds up to 30 m.p.h.

The standard 30 ft. jib can be extended by 10 ft. units.

RATCHET KEY

For use with the Kee Klamp system of tubular construction in which the tube joints are secured by a grub screw, a ratchet spanner has been developed to replace the bent bar type of key. Manufactured by George H. Gasgoigne Company, Limited, Gasgoigne House, Reading, Berks., the spanner includes a reverse mechanism to enable it to be used either way up, and can be supplied with three different sizes of double-ended key. The first is for ⅜ in., the second for ⅜ in. one end and ¼ in. at the other, and the third has ¼ in. and ⅜ in. ends, and is designed for the new large size of screw. A hole is provided at the outer end of the handle so that the spanner can be attached to the operator by a cord—a useful arrangement when operating at some height above the ground.

AMERICAN AIRLINERS FLY

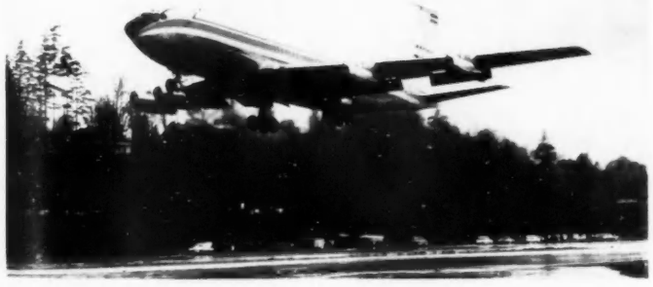
Towards the end of last year two significant first flights took place in the United States—that of their first propeller-turbine airliner, the Electra designed and constructed by the Lockheed Aircraft Corporation, Burbank, California, and that of the first production 707 Jet Stratoliner, by the Boeing Airplane Company, Seattle.

The Electra flew, in fact, 56 days ahead of schedule. Designed for short-to-medium range operations, with a capacity for up to 91 passengers and a cruising speed of 405 m.p.h., it is competitive with the Rolls-Royce Tyne-powered Vickers Vanguard—which is expected to be somewhat faster—on order for British European Airways and Trans-Canada Air Lines (20 each). The Vanguard is expected to fly in the latter part of this year. The Electra has so far secured 144 orders—mainly by American air lines, but including 12 for K.L.M. and four for Australian National Airlines.

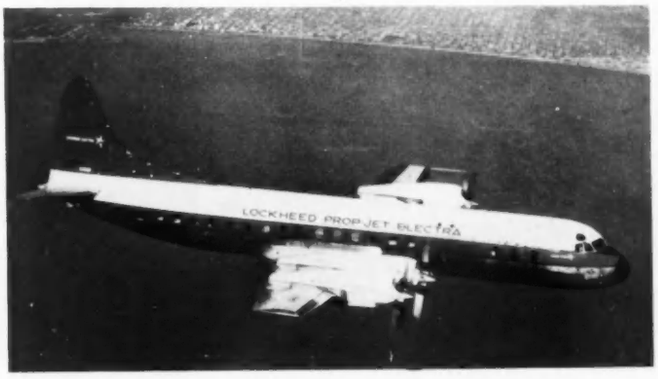
The Boeing 707 Jet Stratoliners are expected to go into commercial service early in 1959 with Pan American World Airlines on international routes, followed by American Airlines on United States domestic routes. In addition to the Jet Stratoliner, a long-range aircraft intended mainly for trans-continental operations, and powered by four Pratt & Whitney JT3 12,000 lb. thrust turbojets fitted with sound suppressor/thrust reversers, there is a larger Boeing 707 Intercontinental, with both greater wing span and longer fuselage, designed for non-stop trans-oceanic operations with a range of more than 4,500 miles with full payload. This version is powered either by 15,500 lb. thrust Pratt & Whitney JT4A turbojets or by 16,500 lb. thrust Rolls-Royce Conway by-pass engines, the latter being the choice of British Overseas Airways Corporation, Deutsche Luft Hansa and Air-India International. A third member of the Boeing commercial-jet family, on order for United Air Lines, is the 720, an intermediate-range aircraft of the same external dimensions as the Jet Stratoliner. Depending on the configuration and interior arrangement, the capacities range up to 180 passengers. So far a total of 162 Boeing jet airliners have been ordered by 14 of the world's major air lines.

GAS FOR PETROL ENGINES

The J. & S. Carburettor Company, P.O. Box 10391, 2634 North Beckley, Dallas, Texas, U.S.A., are offering conversion sets for petrol engines to enable them to run on liquefied petroleum gas. It is claimed that the cost of conversion is reasonable and that since the gas has a high octane rating (between 92 and 100) without any corrosive additives, the engine life and performance will be improved. It is also pointed out that the gas does not condense even in cold weather, and will always enter the cylinders as a dry gas. At present, the gas, which consists mainly of propane and butane, is not subject to tax and, being considered by the oil companies as more or less a by-product, is available at a reasonable price. The calorific value per pound is approximately the same as for petrol.



The Boeing 707 Jet Stratoliner takes off on its maiden flight.



The Lockheed Electra propeller-turbine medium-range airliner in flight.

Special Article

GO INTO TRAINING FOR COMPUTERS

*By John Diebold**

These two machines at R.A.E. Farnborough have worked effectively on scientific research. Integrating them into a business firm could be a research project itself. But firms want to know the capabilities of computers. This month a team headed by John Diebold will run a British Institute of Management course in London on automatic data processing.

The great issues of the world can often be narrowed to a single point. So it is, I think, with the complex issue of automation. The marvellous machines and the problems they pose management are enormously complicated. But if we are willing to take the time and trouble of giving a fresh look at the changes automation is bringing, and to ask a few simple questions about the meaning of those changes, I think we will find that one problem persistently emerges as both the most basic and the most difficult one.

That problem is *education*.

The changes involved in putting automation to work are such that training people is the real problem. As a result, business and industry are going to have to take the responsibility for the most colossal job of education they have ever faced. And it will not be so simple a job as training workers in specific skills such as programming computers, although that is a part of it.

To-day we have a large number of splendid new machines as technically complex as any man has ever built. Well over 1,000 computers are in operation in the United States alone. But if the real facts be known very few of them are being used in a way that even begins to exploit their full potentialities. In fact, all but a tiny fraction are being used to do precisely what was done equally well, and in many cases for far less cost, by punched-card machines. This is an almost unequalled example of sheer waste of a great business resource. It is something like as wasteful as mining a whole mountain of iron and then throwing away all but the low-grade ore.

Computers are being badly used because there is so little understanding of how they should be used and because there is a widespread underestimation of the magnitude of the task of using them properly. The practical problem business faces to-day, not in some vague to-morrow, is the problem of basic training and education of the men and women in business—not just in how to work the machines but in how to use them to solve management problems.

The reason this is not yet widely recognised, I believe, is that most management has been too uncritical in accepting what it has been told are the chief facts about automation. Month in and month out, the businessman reads that the ultimate in automation is a computer: a fascinating, intricate machine that can do arithmetic at the speed of light. This machine, he is told, is the answer to a personnel manager's prayer because it never makes a mistake, or gets a headache in the middle of the afternoon, or leaves its department to get married.

He is seldom told that anything the machines may do to relieve a shortage of clerks is trivial compared with what they could do to improve the way his business runs. And he is seldom told that the machines are the least important aspect of automation. He does not yet understand that a computer is not, by itself, automation, however big and fancy and expensive it may be, that it is nothing more than a tool, just as surely as a hammer or a wrench or a typewriter or an adding machine is a tool.

The machines of automation are only symbols of fundamental developments that are taking place in the way we organise our world. The training of management personnel must reflect this fact. But such education programmes as have accompanied automation hardly even begin to reflect it because businessmen who understand this themselves are as rare as whooping cranes.

* President, John Diebold and Associates Incorporated, New York.

Pre-occupation with hardware is by no means unique to automation. It was true of the first industrial revolution as well. The symbol of that great movement was power-driven machinery. But, as Paul Mantoux points out in his excellent study, *The Industrial Revolution in the Eighteenth Century:*

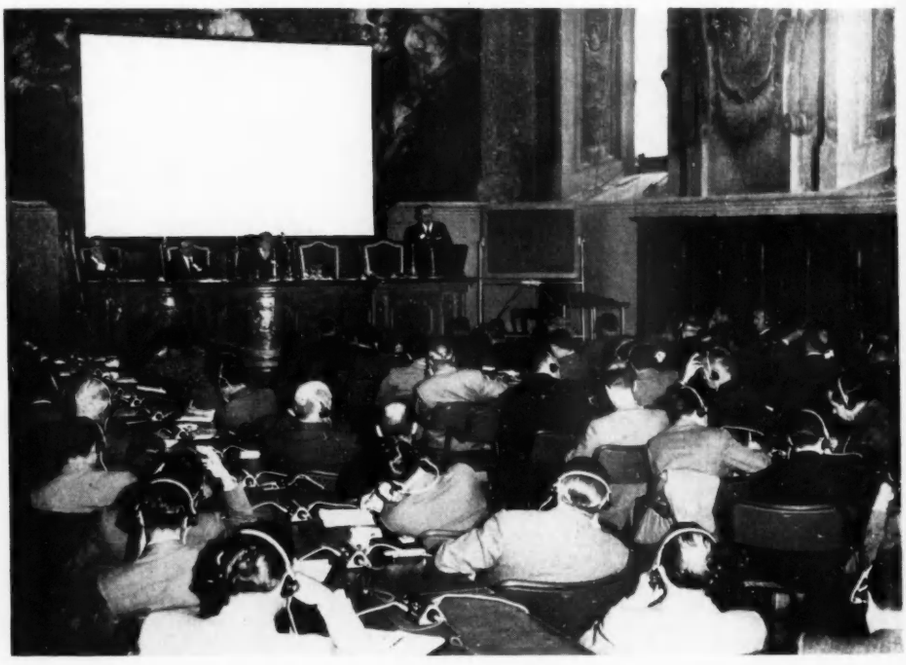
> ". . . the use of machinery itself, important as are its consequences, is only a secondary phenomenon."

It was the changes in human organisation, in this case division of labour and the exchange of commodities, that were the revolution. Power-driven machinery was the tool that made the revolution possible and made it work.

To get some idea of the extent and depth of the changes that are starting to take place through automation, think for a moment of all that is implied in the concept of an integrated system of work; for example, a single computing machine capable of performing many operations at once. This beguilingly simple concept is revolutionary in its meaning and implies a fundamental change in the way we have been doing business for the last two hundred years. It is in direct conflict with the very concept of the division of labour, which has been the key to business organisation from the time of Adam Smith's pin factory to to-day's jet engine production line.

The division of labour, the breakdown of work into simple elements which can be performed repetitively and efficiently, was the great organisational achievement and heart of the factory system that began in the 1750's. It was the division of labour that made it possible for the one-man shop of the artisan and the one-man office of the Eighteenth Century to grow into the complex modern business organisation.

As machines appeared, they were simply inserted into the process to mechanise specific skills. The result is that offices, as well as



Typical of a training approach that can be used successfully is the data processing conference that was held at Milan last October. About 100 businessmen took part. Simultaneous translation equipment can be seen in use.

factories, are organised by functions. Payroll preparation, billing, accounts payable, cost and financial accounting are handled by separate people or separate departments, and where they have been mechanised they are mechanised in the same way. Even the introduction of punched-card machinery in the form of central processing units has not changed this organisation. The same machines may be used to process all types of work, but the jobs are still run separately and are only related to one another in the most general way. The tabulating room, for instance, will make a payroll run, followed by a cost distribution run, then a payables run, each one handled as if it were an entirely separate job.

GOOD-BYE! DIVISION OF LABOUR

Automation and its related technology present us with the means to build a machine system that can handle a great number of information-processing tasks simultaneously. For example, processing new orders, scheduling production, checking raw materials inventory, placing orders for new material, cost distribution and machine loading can all be handled as part of the same interrelated problem—which of course they are in the real world. What this means is that we now have the ability to organise our work in a closer relation to reality. We no longer need to make the organisation of paper work as much of an abstraction from day-to-day happenings as it has always been.

In order to actually do this, however, the businessman is faced with a wholesale reorganisation of work the likes of which he has never before even had to contemplate. If he uses the new machines of automation just to do more rapidly to-morrow what he is already doing to-day he will not have come to grips with the problem; worse, he will have let slip the opportunity of his business lifetime.

At the start, and for quite a few more years, the practical solution to this problem is going to have to come from business itself. There is no hope, in the immediate future, that the buck can be passed to the colleges and schools, although in time, if business understands what its needs truly are and makes these needs known, the educational system will begin to produce young men and women trained not just to use automation equipment but to understand the demands of automation.

But as things stand, the great bulk of the people who are going to be in on the crucial task of administering the conversion to automation, and those who are going to be living and working in a world at least partly automated, are men and women who have already completed their formal education and are now working in business and industry. The responsibility for training these people is largely that of private business, and the task is a far larger one than most managements as yet realise.

Current attempts at training in data-processing depend largely on the courses in how to use the machines that equipment manufacturers give to their customers' personnel and on a few similar university extension programmes. Such training is almost always tied to the machines of automation, and it is hardly adequate even to develop a proper understanding of their machines. It rarely begins to indicate the nature of the problem of how to apply them. Moreover, these schools are tied not only to machines, which is bad enough, but to the machines of one particular manufacturer. Attending only one of these schools is something like expecting to learn about political science by spending a few weeks in the local Tory or Socialist headquarters.

What is needed is training that is more basic, broader in scope, more intensive, given in great depth. The success of a computer programme depends only partly on adequate training in programming for those who will actually convert a business problem to machine instructions—a training problem that, in itself, requires many months of on-the-job instruction beyond the scant month or two in a manufacturer's school, if a prudent businessman is to feel confident that the success or failure of the entire programme is not just a gamble. It depends even more on the training in depth of many individuals within the organisation who are not directly involved in any way with the machine or its operation.

For example, the sales manager must understand a good deal about what a computer can do if he is to even begin to take advantage of its powerful potential for producing new kinds of market and distribution analysis. It is the sales manager, not the head of the data-processing centre, who knows what sales information is essential. The computer man can only present what he thinks the sales manager needs. This is equally true of production control, of cost and financial accounting—indeed, of virtually all areas of business management. Education in breadth as well as in depth is needed, if top management is to know how to specify its requirements and if middle management is to understand how to set out the problem, what kind of data to gather and how to analyse it. I am personally convinced that one reason business computers have not produced better results is that new reports and analyses have almost always been produced—and have had to be produced—by the computer people; executives have not known enough about the computer's potential to phrase their information specifications in any but the most general terms.

Few businessmen have even begun to think about these problems in nearly specific enough terms. But it is business that will have to find the immediate solution through in-plant training programmes and extensive allocations of time and funds for training.

Another thing businessmen are going to have to learn is how to administer programmes of basic research. There is a great deal we do not yet understand about how best to use a computer—a scientific instrument now being adapted to business use—to analyse and improve business organisation and practices. This has some elements of a business problem, some of a genuine scientific research problem. It demands the application of scientific, often mathematical, methods to the problems of the business world.

Business application of these methods has not been very satisfactory. One reason is that management has looked to the mathematician or scientist to come into the company with his magic bag of equations and analyse the problem. As often as not, the scientist has naively accepted the invitation, completely underestimating the complexity of the business problem, wallowing around for months or even for years with little or nothing in the way of useful results.

Another approach having its own place in a successful training system is that shown here. It is a management training seminar being conducted in the New York offices of John Diebold and Associates Incorporated.

WHOSE BURDEN ?

The task here faced by the businessman is to bridge the gap and to administer research efforts that are basic in character. It is no easy problem. The national origin of our two newest moons is standing proof both of the rewards of the scientific approach and of the dangers of applying old-fashioned business management to a research effort. The task of finding new methods of administering and guiding basic research in business is as difficult as it is pressing.

The immediate educational burden imposed by automation is one that must be solved largely in the grey-flannel world of Cash McCall and Willis Wayde. But it does not end there. Business, of course, cannot be expected to shoulder the long-term educational problem alone. In the long run, it must depend on the grey-flannel world of schools and colleges to do the job they exist to do. But its responsibilities do not end when the immediate problem is in hand, for its influence can be important, perhaps crucial, in determining what kind of education will be offered.

We have all heard a lot of talk about the current shortage of engineers. Every year, we are told, the United States falls some thousands short of the number needed; by 1970, according to the United States Office of Education, America will require 50,000 to 60,000 new engineers a year, twice as many as graduated in 1956. We hear much less about the quality of the engineers turned out or about the kind of training they are getting. In the age of automation and other complex new technical development, Professor Gordon S. Brown of the Massachusetts Institute of Technology has pointed out,

> " Those electrical engineers who learned only to go to the handbook for recipes having to do with generators, transmission lines, or telephones are not prepared to cope with new developments, much less to contribute to them. . . . We believe we should prepare students not only for electrical engineering as it exists to-day but to play a creative role in and to lead the electrical engineering of to-morrow."

I think it is a healthy sign that business, too, is coming to recognise that narrowly specialised training is precisely the wrong kind of training for the men who will be expected to play a

Continuing Special Article

creative role in designing and building machines for an age of automation. " Teach your students the basic principles which will never change," one industrialist has urged. " Don't teach them current engineering practice. If you teach them current practice, the chances are that it will not be the practice of my company and, if it is, the practice will be obsolete before the students can use it." One real contribution businessmen can make is not only to support but to spread this point of view.

SELF-DEFEATING SPECIALISATION

But beyond this, there is an even larger educational problem that affects all of us. Despite all that has been said about automation's narrowing man's role, everything I have seen in the actual evolution of automation in the last eight or ten years convinces me that there will be an increasing importance and a greater role for the individual. Of one thing I am certain: automation is going to demand men with far *better* education, in the fullest sense of the word.

The easiest mistake one can make, and certainly the most common, is to assume that scientific training must be the root of all education in the future, and that only those trained as scientists will play important roles. This is a mistake not because technology is unimportant, but because what is truly important, both for technology and for society as a whole, is orderly thinking, and orderly thinking is neither necessarily nor exclusively developed by studying science.

Automation, and other technological advances as well, demand an ability to adapt to rapid change. Change in our frame of reference, change in the parameters of our everyday world, is continual and is increasing rapidly. Training in specific skills, greater and greater specialisation, is a desperate and misguided reaction to such change. It is self-defeating, for to-day's specialty is replaced by to-morrow's new need.

The main task, then, is to train people who can adapt to change. We must do this with managers and we must do it with workers. And in choosing our methods, we can do no better than to heed the advice the philosopher Alfred North Whitehead gave more than 25 years ago, for it is even more true to-day:

" *It is of no use to train the young in one very special process which will probably be superseded before they are middle-aged. Give them alert minds exercised in observation and in reasoning, with some knowledge of the world about them, and with feeling for beauty.*"

REFERENCE

" Automatic Data Processing," a five-day course for management organised by John Diebold and Associates Incorporated, New York, with the support of the British Institute of Management. It will be held at the Washington Hotel, Curzon-street, London, W.1, January 20-24, 1958. The five days are devoted to the following subjects.

1. Critical analysis of automatic data processing to-day. Managing the automatic data processing programme: setting automatic data processing objectives.

2. Managing the automatic data processing programme: how to manage and conduct a system of study; how to match the system with available equipment.

3. Managing the automatic data processing programme: how to assure a successful installation and conversion programme; organisation and selection of personnel.

4. How to staff the automatic data processing centre: training techniques and objectives.

5. How to provide automatic data processing for top management. How to provide automatic data processing orientation for the entire company.

All manuals, cases, and instruction are included in the fee of 85 guineas. The course is based on study and experience of 1,000 computer installations in the United States. Actual case histories will point out the reason for successes and failures in these installations from the point of view of good management. British managers will therefore have the opportunity of learning from the mistakes of others and of equipping themselves to avoid the errors which have cost American firms so dearly.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

LONDON
" Diesel Engines as Applied to Electrical Practice," by H. A. Gill. Central London Branch. White Hall Hotel, Bloomsbury-square, W.C.1. Mon., Jan. 13, 6.30 p.m.

British Computer Society

LONDON
" Physical Aspects of Xerography," by Dr. N. Levin. Caxton Hall, off Victoria-street, S.W.1. Mon., Jan. 20, 6.15 p.m.

Building Centre

LONDON
Film: " The Plywood Story," exhibited by Seaboard Lumber Sales Co., Ltd. Wed., Jan. 15, 12.45 p.m.

Chemical Society

BRISTOL
" The Electron Microscope: Its Application to Chemistry," by Dr. R. H. Ottewill. Bristol Branch. Chemistry Department, The University, Bristol. Thurs., Jan. 16, 5.15 p.m.
ST. ANDREWS
" The Chemistry of Polyester Fibres," by Dr. I. Goodman. St. Andrews and Dundee Branch. Chemistry Department, St. Salvator's College, St. Andrews. Fri., Jan. 17, 5.15 p.m.

Combustion Engineering Association

BIRMINGHAM
" Atomic Energy," by W. R. Wootton, at 11 a.m. Film on " Combustion," at 2.30 p.m. Midland Region. Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham, 2. Mon., Jan. 13.
LEEDS
" Combustion and Control Systems for Small Boilers," by E. Burman. Northern Section. Hotel Metropole, King-street, Leeds, 1. Wed., Jan. 15, 10.30 a.m.*

Diesel Engineers and Users Association

LONDON
Discussion on " Maintenance Routines." General Meeting. Caxton Hall, off Victoria-street, Westminster, S.W.1. Thurs., Jan. 16, 2.30 p.m.

Illuminating Engineering Society

LONDON
" Lighting of Aircraft Flight Decks," by J. W. Strange and B. Stevens. Federation of British Industries, 21 Tothill-street, S.W.1. Tues., Jan. 14, 6 p.m.
MANCHESTER
" Use of Coloured Light," by H. Hewitt. Manchester Centre. Offices of the North Western Electricity Board, Town Hall, Manchester. Thurs., Jan. 16, 6 p.m.*

Incorporated Plant Engineers

BIRMINGHAM
" Fuel Injection," by T. G. Charlesworth. Birmingham Branch. Imperial Hotel, Temple-street, Birmingham. Fri., Jan. 17, 7.30 p.m.
BLACKBURN
" Fuel and Power Policy," by Gerald Nabarro. Blackburn Branch. The Lecture Hall, Blackburn. Thurs., Jan. 16, 7.30 p.m.
DUNDEE
" Planned Maintenance," by A. J. MacIntyre. Dundee Branch. Mather's Hotel, Dundee. Mon., Jan. 13, 7.30 p.m.
MANCHESTER
Discussion on " Plastics in Industry." Manchester Branch. Engineers' Club, Albert-square, Manchester. Tues., Jan. 14, 7.15 p.m.
ROCHESTER
Discussion on " Boiler Inspection and Insurance." Kent Branch. King's Head Hotel, High-street, Rochester. Wed., Jan. 15, 7 p.m.

Institute of Fuel

LEEDS
" Atomisation," by J. R. Joyce. Yorkshire Section. Hotel Metropole, King-street, Leeds, 1. Wed., Jan. 15, 2.30 p.m.

Institute of Marine Engineers

LONDON
" Materials for Superheater Tubes and Supports," by D. W. Crancher. Tues., Jan. 14, 5.30 p.m.*
NEWCASTLE-UPON-TYNE
" Heat Balance Calculations and Their Use in the Installation Design of Steam-Turbine Merchant-Ship Propulsion Machinery," by Commander E. Tyrrell. North East Coast Section. Stephenson Building, King's College, Claremont-road, Newcastle-upon-Tyne. Thurs., Jan. 16, 6.15 p.m.*
KINGSTON-UPON-HULL
" Recent Developments in British Naval Main Propulsion Steam Turbines," by the late F. J. Cowlin and A. F. Veitch. Kingston-upon-Hull and East Midlands Section. Royal Station Hotel, Kingston-upon-Hull. Thurs., Jan. 16, 7.30 p.m.

Institute of Marine Engineers and Institution of Naval Architects

SOUTHAMPTON
" Hull Surveys and Where to Look for Defects," by H. Mackechnie. Southern Joint Branch. Southampton Technical College, St. Mary-street, Southampton. Tues., Jan. 14, 7.30 p.m.

Institute of Metals

LONDON
" The Mechanism of Clustering and Precipitation in Metals," by Dr. David Turnbull. Wed., Jan. 15, 6.30 p.m.
SWANSEA
" Electron Microscopy," by Dr. J. W. Menter. South Wales Local Section. University College, Singleton Park, Swansea. Tues., Jan. 14, 6.30 p.m.*

Institute of Physics

LONDON
" Physical Research in the Research Group of the Atomic Energy Authority," by Dr. B. F. J. Schonland. London and Home Counties Branch. Wed., Jan. 15, 6 p.m.*
BRISTOL
" The General Circulation of the Atmosphere, or Why the Winds Blow," by Professor P. A. Sheppard. South Western Branch. Physics Department, The University, Bristol. Fri., Jan. 17, 7 p.m.

Institute of Road Transport Engineers

LONDON
" Work of the Motor Industry Research Association," by Dr. A. Fogg. Royal Society of Arts, John Adam-street, W.C.2. Thurs., Jan. 16, 6.30 p.m.*
BIRMINGHAM
Discussion on " The Free Piston Gasifier, with Special Reference to Vehicle Applications." Midlands Centre. Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham, 2. Tues., Jan. 14, 7.30 p.m.
NOTTINGHAM
" Selection and Use of Fuels and Lubricants for Road Transport," by C. G. Tressider. East Midlands Centre. Mechanics Institute, Nottingham. Wed., Jan. 15, 7.30 p.m.

Institution of Civil Engineers

LONDON
" Lake Nyasa and the River Shire," by N. J. Cochrane. Tues., Jan. 14, 5.30 p.m.*
BELFAST
" Engineering Education in the Soviet Union," by Professor E. Giffen and P. E. Sleight. Northern Ireland Association. William Whitla Hall, Queen's University, Belfast. Mon., Jan. 13, 5.45 p.m.
LINCOLN
" A Prestressed Concrete Footbridge," by J. H. Vince. East Midlands Associations. Technical College, Cathedral-street, Lincoln. Tues., Jan. 14, 6.15 p.m.
MIDDLESBROUGH
" Water Tower Construction," by J. O. C. Ritchie. Northern Counties Association. Cleveland Scientific and Technical Institution, Middlesbrough. Wed., Jan. 15, 6.15 p.m.

Institution of Electrical Engineers

LONDON
Discussion on " The Use of Electricity in the Garden by Amateurs," opened by M. M. Harvey. Mon., Jan. 13, 5.30 p.m.*
" Recent Developments in Low-Voltage High-Rupturing-Capacity Fuse Links," by R. H. Dean. Utilization Section. Thurs., Jan. 16, 5.30 p.m.*
BRIGHTON
" The B.B.C. Sound Broadcasting Service on Very-High Frequencies," by E. W. Hayes and H. Page. Southern Centre. Brighton Technical College, Brighton. Wed., Jan. 15, 6.30 p.m.
BRISTOL
" The B.B.C. Sound Broadcasting Service on Very-High Frequencies," by E. W. Hayes and H. Page. Western Centre. University Engineering Laboratories, Bristol. Mon., Jan. 13, 6 p.m.*
HULL
Chairman's Address by A. J. Coveney. North Midland Centre. Offices of the Yorkshire Electricity Board, Ferensway Hull. Thurs., Jan. 16, 6.30 p.m.
NEWCASTLE-UPON-TYNE
" Earthing of Low- and Medium-Voltage Distribution Systems and Equipment," by F. Mather. North Eastern Centre.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
British Computer Society, 29 Bury-street, St. James's, London, S.W.1.
Building Centre, 26 Store-street, London, W.C.1. (MUSeum 5400.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Combustion Engineering Association, 6 Duke-street, St. James's, London, S.W.1. (WHItehall 5536.)
Diesel Engineers and Users Association, 19 Old Queen-street, London, S.W.1. (TRAfalgar 5597.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 12 The Parade, Solihull, Warwickshire. (Solihull 1111.)
Institute of Fuel, 18 Devonshire-street, Portland-place, London, W.1. (LANgham 7124.)
Institute of Marine Engineers, Memorial Building, 76 Mark-lane, London, E.C.3. (ROYal 8493.)
Institute of Metals, 17 Belgrave-square, London, S.W.1. (BELgravia 3291.)
Institute of Physics, 47 Belgrave-square, London, S.W.1. (BELgravia 6111.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Designers, 38 Portland-place, London, W.1. (LANgham 8847.)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. (Central 5181.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James' Park, London, S.W.1. (WHItehall 7476.)
Institution of Mining and Metallurgy, 44 Portland-place, London, W.1. (LANgham 3802.)
Institution of Naval Architects, 10 Upper Belgrave-street, London, S.W.1. (SLOane 4622.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Institution of Public Health Engineers, 118 Victoria-street, London, S.W.1. (VICtoria 3017.)
Institution of the Rubber Industry, 4 Kensington Palace-gardens, London, W.8. (BAYswater 9101.)
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1. (SLOane 7128.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row London, S.W.1. (VICtoria 0786.)
Manchester Association of Engineers, 18 Booth-street, Manchester 2. (Central 1717.)
Pipeline Industries Guild, 7 Iddesleigh House, Caxton-street, London, S.W.1. (ABBey 6925.)
Royal Statistical Society, 21 Bentinck-street, London, W.1. (WELbeck 7638.)
Sheffield Metallurgical Association, 66 Ringstead-crescent, Sheffield 10. (Sheffield 62144.)
Society of Chemical Industry, 14 Belgrave-square, London, S.W.1. (BELgravia 3681.)
Society of Instrument Technology, 20 Queen Anne-street, London, W.1. (LANgham 4251.)

Neville Hall, Westgate-road, Newcastle-upon-Tyne. Mon., Jan. 13, 6.15 p.m.

Institution of Engineering Designers

NEWCASTLE-UPON-TYNE
"Shielded Arc Welding," by W. A. Woolcott; and films on welding. North East Branch. Northern Architectural Association, 6 Higham-place, Newcastle-upon-Tyne. Mon., Jan. 13, 7.15 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Craneage in Works and Shipyards," by D. L. Nicolson. Tues., Jan. 14, 6.30 p.m.

Institution of Heating and Ventilating Engineers

BIRMINGHAM
"The Future of Electricity as Applied to Space Heating," by S. C. Dinenage. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham, 2. Tues., Jan. 14, 6.30 p.m.
BRISTOL
"Mechanical Services in the Central Area of London Airport," by R. E. Tully. South Western Branch. Library, R.W.A. School of Architecture, Bristol. Tues., Jan. 14, 6.30 p.m.

Institution of Mechanical Engineers

LONDON
"Prevention of Corrosion in Car Bodies," by Dr. T. P. Hoar. Automobile Division. Tues., Jan. 14, 6 p.m.*
Discussion on "Export Packing of Engineering Products." Industrial Administration and Engineering Production Group. Thurs., Jan. 16, 6.45 p.m.*
Thomas Lowe Gray Lecture: "Machinery for Cross-Channel Passenger Ships," by E. L. Denny. Fri., Jan. 17, 6 p.m.*
IPSWICH
Annual General Meeting. "The American System of Education and Training of Mechanical Engineers," by Dr. H. S. Arms. Eastern Branch. Great White Horse Hotel, Ipswich. Tues., Jan. 14, 7.30 p.m
MANCHESTER
Annual General Meeting. "Rotary Shaft Seals: The Sealing Mechanism of Synthetic Rubber Seals Running at Atmospheric Pressure," by Dr. E. T. Jagger. North Western Branch. Engineers' Club, Albert-square, Manchester. Thurs., Jan. 16, 6.45 p.m.
MAIDSTONE
Annual General Meeting and Chairman's Address. Southern Branch. Royal Star Hotel, Maidstone. Wed., Jan. 15, 7.30 p.m.

Institution of Mining and Metallurgy

LONDON
"Microradiographic Study of the Action of Flotation Reagents," by Professor I. N. Plaksin; and "The Training of Mining Engineers," by A. W. S. Schumann. Geological Society, Burlington House, Piccadilly, W.1. Thurs., Jan. 16, 5 p.m.*

Institution of Production Engineers

LONDON
"A New Approach to Production Control," by J. L. Burbidge. London Section. Royal Empire Society, Northumberland-avenue, W.C.2. Thurs., Jan. 16, 7 p.m.
BIRMINGHAM
"Inter-Process Mechanisms for Press Work," by J. P. Udall. Birmingham Section. James Watt Memorial Institute, Great Charles-street, Birmingham. Wed., Jan. 15, 7 p.m.
LEEDS
"Correct Application of Electrical Equipment to Production Machinery," by W. L. Sims. Leeds Section. Hotel Metropole, King-street, Leeds. Mon., Jan. 13, 7 p.m.
PETERBOROUGH
"Cost Reduction by Production Planning and Control," by R. J. Smithson. Peterborough Section. White Lion Hotel, Church-street, Peterborough. Tues., Jan. 14, 7.30 p.m.

Institution of Public Health Engineers

LONDON
"Smoke-Free Incineration of Liquid Wastes and Sludges," by R. F. West. Caxton Hall, off Victoria-street, S.W.1. Thurs., Jan. 16, 6 p.m.*

Institution of the Rubber Industry

LONDON
"Modern Testing Methods and Equipment," by F. N. B. Bennett, at 5.30 p.m. "New Synthetic Rubber in Cables," by W. S. Penn, at 7 p.m.* London Section. 26 Portland-place, W.1. Tues., Jan. 14.

Institution of Structural Engineers

PLYMOUTH
"Lifting Equipment," by W. R. Hockaday. South Western Counties Branch. Duke of Cornwall Hotel, Plymouth. Fri., Jan. 17, 6 p.m.*

Junior Institution of Engineers

LONDON
"Journal Bearings in Theory and Practice," by Dr. F. T. Barwell. Fri., Jan. 17, 7 p.m.*

Manchester Association of Engineers

MANCHESTER
"Corrosion in Action," by R. Butcher. Engineers' Club, Albert-square, Manchester. Fri., Jan. 17, 6.45 p.m.

Pipeline Industries Guild

LONDON
"Combating Internal Corrosion," by J. Morgan and D. S. Tullock. Caxton Hall, off Victoria-street, S.W.1. Tues., Jan. 14, 6.30 p.m.

Royal Statistical Society

BRISTOL
"Statistical Aspects of Market Research," by D. H. Pickard. Bristol Study Group. The University, Bristol. Thurs., Jan. 16, 5.45 p.m.*
CARDIFF
"Simple Experimental Designs," by Dr. D. R. Cox. South Wales Industrial Applications Group. University College, Cathays Park, Cardiff. Mon., Jan. 13, 6.45 p.m.

Sheffield Metallurgical Association

SHEFFIELD
Annual General Meeting of the Refractories Group, and Chairman's Address by Dr. A. H. B. Cross. B.I.S.R.A. Laboratories, Hoyle-street, Sheffield. Tues., Jan. 14, 7 p.m.

Society of Chemical Industry

LONDON
"Stress Corrosion Cracking," by T. P. Hoar and J. G. Hines. Wed., Jan. 15, 6.30 p.m.

Society of Instrument Technology

NEWCASTLE-UPON-TYNE
"Modern Types of Electronic Recorders," by F. A. Bergen. Newcastle Section. King's College, Stephenson Building, Newcastle-upon-Tyne. Wed., Jan. 15, 7 p.m.

Atomic Review

High Temperatures and Energies

Two new research establishments are being built in Britain. One, the National Institute for Research in Nuclear Science, will be devoted to fundamental research and is to have a proton synchrotron capable of accelerating particles to high energies. The other, at Winfrith Heath, will be concerned rather with the applications of nuclear science; it is to have an experimental reactor designed to operate at temperatures considerably in excess of those currently employed in gas-cooled reactors. After an announcement concerning a new atomic power group, the notes below discuss certain aspects of high-temperature reactors and ceramic fuels, and refer to a number of high-energy particle accelerators projected or operating. There are also several notes on controlled thermonuclear fusion.

Group to Build Small Nuclear Power Plants

Ruston and Hornsby Limited, of Lincoln, and J. L. Kier and Company, Limited, of London, have agreed to work in close technical collaboration on the design, development and building of nuclear power stations of 5 to 25 MW electrical generating capacity. A combined design team is being established for this purpose at the Lincoln Works of Ruston and Hornsby Limited.

Ruston and Hornsby are well known for their work in the turbine field and in particular for the success of their 750 kW TA gas turbine. J. L. Kier are civil-engineering contractors.

Advanced Gas-Cooled Reactors

Reactors with Closed-Cycle Gas-Turbines

Work is proceeding in Britain and the United States on the study of gas-cooled reactors using ceramic fuels. Such fuels may comprise discreet elements or be dispersed in the graphite moderator. Systems of this kind will require some enrichment but breeding will also be possible. Such reactors are likely to operate at temperatures up to 600 deg. C. and perhaps at a later date up to 800 deg. C. and to make practicable the use of closed-cycle gas turbines. But this development will require considerable engineering work and it is likely to be some years before a scheme of this kind is tested in practice. The elimination of intermediate heat exchangers and secondary steam circuit will permit a considerable economy, and if sufficient enrichment is employed compact plants of comparatively modest power ratings will be possible.

The high-temperature reactor should be regarded as a natural development of existing gas-cooled reactors and not a new system. It is likely that early models will employ heat exchangers and a secondary steam circuit as with the Calder Hall reactors. The accident at Windscale may mean that extensive technical work will be required before radioactive gas will be permitted to pass through a circuit including mechanical parts. In the words of Sir Alexander Fleck: the lesson of Windscale is "the need for careful design."

Nevertheless, the theoretical economies of the closed-cycle system are so attractive that engineering development work may be undertaken at an early date. Fig. 1, which has been adapted from a United Kingdom Atomic Energy Authority sketch, shows a possible arrangement for a closed-cycle high-temperature system. An experimental reactor using ceramic fuel is to be built at the United Kingdom Atomic Energy Authority establishment on Winfrith Heath, Dorset. An introductory article on the very high temperature (VHT) reactor appeared in ENGINEERING, vol. 182, page 725, 1956.

Australian Work on High-Temperature System

The research programme of the Australian Atomic Energy Commission includes investigation of the high-temperature gas-cooled reactor. The results so far obtained are stated to vindicate the choice of this system. The system would eventually operate most economically on the uranium 233—thorium breeder cycle, but is likely to be started with uranium 235 or plutonium. If the research problems can be solved, this reactor system gives promise of producing base-load electric power at less than $\frac{1}{2}d.$ per kWh, and at a capital cost of the same order as those of conventional power stations. It is also ultimately capable of driving a gas turbine. Two applications of the system have a particular interest to Australia: (*a*) self-sustaining breeder reactors supplying base-load electric power in the range of 50 to 200 MW, and (*b*) small systems in the 5 to 10 MW range for remote localities. These systems would have a conversion factor of less than one, and thus would not be self-sustaining in fuel; their fuel could be supplied from natural uranium or from breeder reactors located elsewhere in Australia.

There are several technical variations of the high-temperature gas-cooled reactor, which are summarised as follows. (1) The neutron moderating material may be graphite, beryllium, beryllia or a mixture of these. Australia has a special interest in reactors employing some beryllia or beryllium because of their possibilities of being adapted to smaller power units. (2) The coolant gas may be helium, hydrogen, carbon dioxide, nitrogen or possibly argon. The choice of coolant gas for a particular system will depend, not only upon its known thermodynamic properties, but also upon its yet unknown chemical compatibility under radiation and at high temperatures with other reactor materials. (3) The

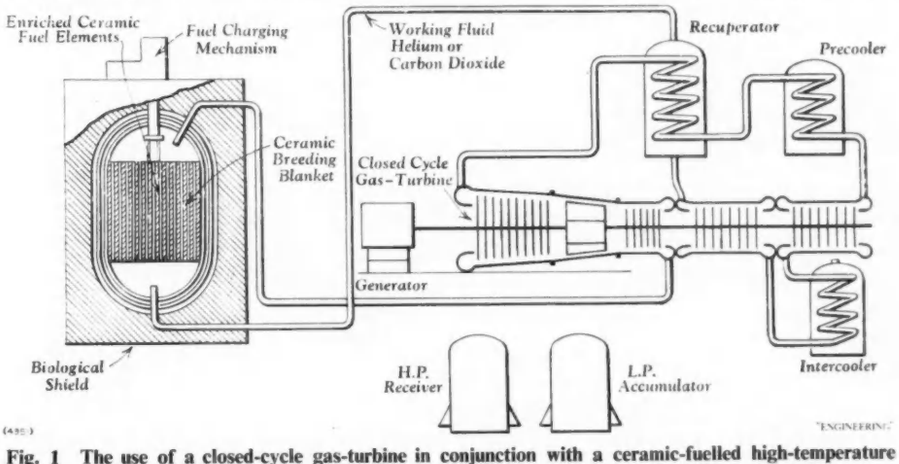


Fig. 1 The use of a closed-cycle gas-turbine in conjunction with a ceramic-fuelled high-temperature reactor is still fairly remote, but it is a sufficiently attractive system to merit study.

Continuing Atomic Review

fuel element can take a variety of forms, but must provide for an element containing some fissile material (uranium 233, uranium 235 or plutonium) and some fertile material (uranium 238 or thorium). The element may be usefully constituted in some of the moderator, or as a ceramic. It is necessary that the fuel element be stable at high temperatures (up to 2,000 deg. C.) and high radiation fluxes. It must also be chemically compatible with moderator and with coolant.

Studies Completed

A useful start on the Australian research programme has been made in the United Kingdom. General feasibility studies have been undertaken of critical sizes and fuel investments; theoretical investigations have been made of the properties of various gases as coolants. These studies have shown the high-temperature gas-cooled system to be a very promising one, if the other problems of fuel element and compatibility can be solved.

The main investigation effort has been directed at problems concerning the fuel elements. Beryllia, beryllium and graphite have all been examined theoretically as fuel diluents on a thermal stress basis. An initial fuel sample testing programme has been drawn up for HIFAR, and steps taken to order the materials and the metallurgical fabrication equipment needed to make the fuel samples. The post-irradiation facilities required to examine the irradiated fuel samples are at present being designed at Lucas Heights. Known information on the compatibility of gas coolants has been assembled, and the gaps, where research is necessary, defined. Some preliminary economic and technical studies of the related chemical processing have been made.

Breeding Delay

Breeding reactor systems based on the thorium-uranium 233 cycle, introduce problems of chemical processing, which is complicated by the 27 day decay period for the thorium-uranium 233 transition; it calls for the separation of protoactinium, an intermediate product which appears during the transition. The separation by solvent extraction of reactor fission products is difficult in the case of elements such as ruthenium which have several valency states.

Ceramic Fuels

Experiments have been reported to show that oxides and carbides of fissile and fertile materials can be made to accommodate fission-product gases without swelling. It has been claimed that burn-ups in excess of 25,000 MWdays per ton may be achieved with uranium oxide or mixed uranium and thorium oxides, but this figure is likely to prove extremely optimistic. Density is low and thermal conductivity poor. Ceramic fuels are said to have good neutron economy and conversion ratio.

The melting point of UO_2 is about 2,800 deg. C., but melting may occur inside a solid bar before the surface reaches this temperature, causing splintering ; it does not react with zirconium and is corrosion resistant to water up to 300 deg. C.; it is also resistant to irradiation. Uranium silicide has also been considered. The carbide and the silicide have cubic lattices and are not subject to phase changes. It is significant that plutonium carbide and uranium carbide have the same structure.

Cermets

Cermets are mixtures of ceramic and metal, and are an attempt to achieve the good properties of both. An alloy of 2 per cent. or less has the characteristics of the major fraction.

Cermets described in a U.K.A.E.A. patent application comprise 5 per cent. to 25 per cent. by weight of silicon and 95 per cent. to 75 per cent. by weight of uranium dioxide (UO_2), or U_3O_8. The cermets are formed by cold compacting a mixture of the components as powders in a mould at 1,000 lb. per sq. in., heating the mixture to 1,000 deg. C., and hot pressing at 2,000 lb. per sq. in. and at least 1,400 deg. C. The products have low porosities, high oxidation resistance compared with uranium dioxide, especially between 600 deg. and 800 deg. C., and improved thermal shock resistance compared with uranium dioxide. These properties combined with the low neutron absorption of silicon, and the ease of separation of the components during processing after use, make the cermets suitable for use in nuclear reactors operating at temperatures up to 1,000 deg. C.

Accelerators

Proton Synchrotron Building

In a paper entitled " Building for Atomic Energy " presented at a meeting of the Royal Institute of British Architects, Sir John Cockcroft gave details of buildings for housing radioactive chemical installations and of the building now being constructed to house the giant proton synchrotron of the National Institute for Research in Nuclear Science. The proton synchrotron, which is part of the equipment of the Rutherford Laboratory, is designed to accelerate nuclear particles within a chamber 150 ft. in diameter employing 6,000 tons of magnetic blocks. An article by Dr. T. G. Pickavance, Director of the Rutherford Laboratory, dealing with this and other high-energy accelerators, was published in Atomic Review last week. Fig. 2 shows the layout of the Laboratory.

The machine will be located on a surface which must depart from a plane by less than 1 mm. A circular reinforced concrete building 200 ft. in diameter has been designed, capable of taking the heavy load and of retaining great stability. The roof will be made of concrete 4 ft. 6 in. thick covered with 10 ft. of earth with provision for a further 10 ft. over the magnet should this be necessary. The bulk of the shielding to provide protection against the 7 GeV particles which will be generated will consist of earth mounds. A large amount of space has also to be provided for experimental workers who will use powerful magnets to guide the particles to their apparatus. At the same time shielding blocks have to be provided to protect personnel.

The main shielding wall separating the magnet room from the experimental area will be of concrete 28 ft. thick, with movable blocks up to a height of 12 ft. The experimental area is to be shielded on all sides by earth banks. External beams are to be absorbed at the ends of long tunnels driven into the back wall of the experimental area and the contours of the site have been exploited to ensure that the most intense particle beams are driven into a hillside and come to rest underground. Overhead shielding will be provided at the targets where necessary. A control room block contains the facilities essential to the remote operation of the machine, together with counting rooms, an experimental preparation area of 4,000 sq. ft. and accommodation for the operating crew. The motor alternator house and offices are nearby.

Argonne Proton Synchrotron

Argonne National Laboratory has received authorisation from the United States Atomic Energy Commission to proceed with design studies for a 12·5 GeV zero-gradient proton synchrotron. Cost of the facility is estimated at 27 million dols. and the U.S.A.E.C. has made available 1,500,000 dols. initially for detailed design work. It is said that the new Argonne machine will produce greater numbers of accelerated particles than any other of the comparable accelerators now in operation or under construction anywhere in the world. Fig. 3

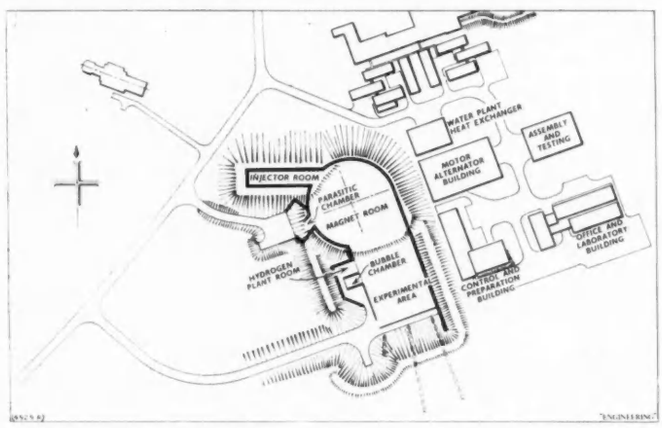


Fig. 2 General layout of the Rutherford Laboratory, showing the arrangement of the projected 7 GeV proton synchrotron.

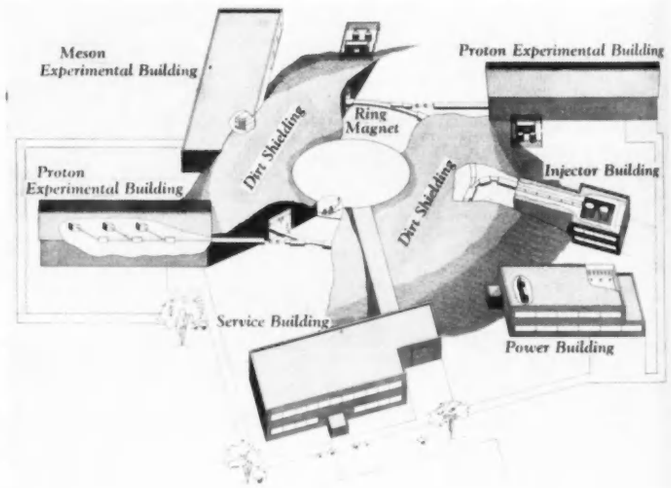


Fig. 3 Proposed design for a 12·5 GeV proton synchrotron to be built at the Argonne National Laboratory. Details are given below.

Features of Proposed Argonne Proton Synchrotron

Injector Building.—Hydrogen ions (protons) are produced and speeded up to 50 MeV (62,000 miles per second) in a linear accelerator.

Ring Magnet.—The protons are then projected into a channel inside the main ring magnet. They travel round the 600 ft. circumference circle 1·5 million times, travelling 175,000 miles. While in the magnet the protons are accelerated to a final energy of 12·5 GeV (185,000 miles per second—almost the speed of light). The time taken is one second.

Proton and Meson Experimental Buildings.—The high-speed protons are then brought out of the magnet and sent into one of the experimental areas, where they are used to bombard other atoms, in order to study the structure of nuclei and the forces that hold them together.

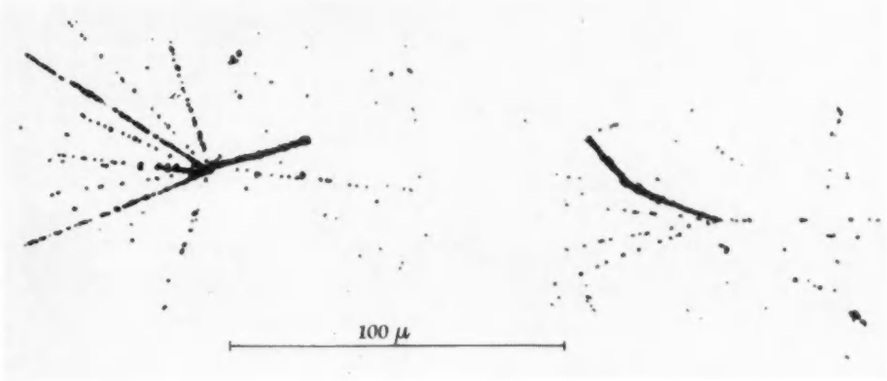
Power Building.—Electric generators and rectifiers apply a power pulse to the ring magnet once very four seconds. This reaches a peak power of 10,000 kW.

Service Buildings.—Office and auxiliary laboratory building.

Fig. 4 (left) A report on early work carried out using the 10 GeV proton synchrotron at the Soviet Joint Nuclear Research Institute, Dubna, includes reference to emulsion photographs of some 500 nuclear events.

Fig. 5 (below) Microphotograph of two nuclear events obtained with the Soviet 10 GeV machine.

On the right a 9 GeV proton is seen colliding with an atom to give one fast particle, and three other particles. On the left, the new particle collides with another atom to give eleven new particles, of which six appear to be fast mesons.



shows how the proposed facilities for the synchrotron would appear if completed according to present plans. The facilities will be located at Argonne's main site, near suburban Lemont, Illinois, 25 miles south-west of Chicago.

It is the laboratory's hope that the scientists of the Midwest Universities Research Association who have conceived the design of the proposed machine and who are carrying out the theoretical and model studies to establish its feasibility, will continue to provide their support.

Soviet Proton Synchrotron

The scientific council of the Joint Nuclear Research Institute at Dubna, U.S.S.R., have recently heard reports on work carried out at the Institute (see Atomic Review for December 13, 1957). Professor Vladimir Veksler, head of the high-energy laboratory, reported on studies performed using the 10 GeV proton synchrotron (synchro-fazatron); it is shown in Fig. 4. An early experiment has been the establishment of interaction runs with 9 GeV protons by directing these particles into photographic emulsion. Interaction runs are the distances covered by protons before being involved in collisions with other nuclei. Emulsion records of some 500 events, such as the two illustrated in Fig. 5, have been obtained.

It is reported that emulsion microphotographs have shown the complete disintegration of silver nuclei under bombardment, with " evaporation " of all nucleons. This effect is said to be the result of heating to temperatures in the region of 10^{11} deg. C. during absorption of the immense energy transmitted from the proton to the nucleus. A number of collisions between primary protons and hydrogen nuclei have also been recorded. In these cases as distinct from the normal scattering shown in Fig. 5, a narrow beam of radiation is formed comprising " relativistic " particles, presumably extremely short-lived mesons.

Other work discussed included a method of automatically examining photographic plates, based on the use of computers, and the development of a consistent theory of superconductivity by Academician N. N. Bogolyubov based on his earlier theory of superfluidity. A Chinese physicist Wang Kang-chang, is shortly to begin studies with a propane-filled bubble chamber.

Fusion

High Temperatures at Home and Abroad

Recent conjecture on the results obtained in controlled thermonuclear experiments has tended to be confusing, but it appears to be certain that temperatures in excess of 5 million deg. C. have been achieved at Harwell using ZETA. Sir Alexander Fleck stated last Friday that temperatures of this order had been recorded by the team working under Dr. P. C. Thonemann. But there has so far been no public statement to the effect that neutrons of thermonuclear origin have been detected. Such a statement is expected, however, to be made shortly in the House of Commons. That thermonuclear reactions have occurred is to some extent confirmed by the report that controlled fusion reactions have been achieved in the Soviet Union, though the temperature claimed by Academician A. Terpigorev in this case was only 1 million deg. C.

It should be emphasised that however successful these experiments may have been, the practical application of the fusion reaction continues to be remote. Considerably higher temperatures will be necessary before there can be any approach to a profitable energy balance, since it is only at higher temperatures that reactions are likely to occur with adequate frequency. Beyond that lie the engineering problems of converting the energy evolved into electric power.

Other Approaches

The United States are reported to be engaged on some six different approaches to the fusion reaction, and it is worth remembering that the most familiar method using pulsed gas discharges is by no means the only possibility. Fusion reactions are even believed to have occurred in liquid hydrogen at low temperatures by way of a mechanism that is thought, however, to be of no more than academic significance. Nevertheless, it is understood that experiments are to be carried out on one of the Dubna accelerators in the Soviet Union to establish the existence of a hypothetical long-lived negative meson the existence of which might alter the situation considerably. The catalytic effect of certain mesons was discussed in Atomic Review on January 11, 1957. Since the reaction was first noted in America it is probable that work along these lines is also being pursued there. It is significant that the discovery arose from bubble-chamber observations; a bubble chamber is a device using a super-cooled liquid (in this case hydrogen) for studying the tracks of high-energy particles obtained, say, from an accelerator, such as the 7 GeV proton synchrotron being built at the Rutherford Laboratory.

Shock Waves

One approach to the fusion reaction that has been discussed is the use of shock waves, and it is known that work on this method has been undertaken in this country (Atomic Review, last October 11): plasmas are produced in supersonic shock tubes. In America the Lockheed Aircraft Corporation state that they are using hydromagnetic shock waves at 100,000 deg. C. and travelling at a hundred thousand miles an hour to study the flow of ionised gases or plasmas in these conditions. Such work may be concerned primarily with advanced propulsion systems, but it is also relevant to thermonuclear studies.

Producing Plasmas

In experiments aimed at finding the optimum conditions for producing a highly ionised plasma in hydrogen, it was found, at the Massachusetts Institute of Technology Research Laboratory of Electronics, that a more efficient transfer of energy from a microwave field to a plasma took place when the operating frequency was equal to the electron cyclotron frequency. This raised the question whether a similar selective absorption occurred when the operating frequency was equal to the ion cyclotron frequency.

In a letter to *Nature* (page 1468, December 28, 1957), Mr. A. W. Bright and Mr. K. Ramanathan describe some preliminary experiments they have carried out on this problem at the Department of Electrical Engineering, Imperial College of Science and Technology, London. Their discharge was contained in a short cylinder 8 cm. in diameter and 3 cm. between parallel faces. A radial radio-frequency electric field was provided by means of parallel plate electrodes outside the tube. An axial magnetic field of some 3,000 gauss was used.

The ion cyclotron frequency can be readily calculated and, at the magnetic field strength stated, has a value of about 4·56 Mc/s for atomic hydrogen. In their experiments the authors found that below the cyclotron frequency the voltage across the discharge tended to be independent of frequency. Above the cyclotron frequency there was a progressive decrease in voltage. They remark that with their present apparatus sharp resonances were not to be expected. It is hoped to continue the work with more refined apparatus.

Fusion References

Previous references to fusion work which have appeared in ENGINEERING are as follows: vol. 180, page 234, 1955; vol. 181, page 318, 322, 355 and 409, 1956; vol. 182, pages 124 and 187, 1956; vol. 183, pages 58, 121, 217 and 540, 1957; vol. 184, pages 29, 156, 347, 474, 538, 610, 764, 827 and 828, 1957.

General Notes

Britain and Italy Conclude Agreement

Britain and Italy have concluded a 10-year agreement for co-operation in the peaceful uses of atomic energy. Said to be the first comprehensive agreement in this field between Britain and a foreign country, it provides for the exchange of non-classified information between the United Kingdom Atomic Energy Authority and the Italian Government. In addition the U.K.A.E.A.

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undertake the following services: 1. sale, or assistance in purchase, from United Kingdom sources, of fuel for research and the operation of power reactors in Italy; 2. assistance in the supply of research and power reactors from Britain; 3. processing of used atomic fuel; 4. help in the design, construction, and operation of facilities for the manufacture of atomic fuel and the processing of used fuel in Italy; and 5. provision of training facilities in atomic matters for Italian students and trainees recommended by the Italian Government.

The agreement also allows for the transfer of the same facilities to Euratom, which is due to begin operations this year, though Britain's agreement to this transfer must be obtained specifically. The agreement is to be ratified shortly. Partial agreements concerning scientific research or the exchange of non-classified information already exist between Britain and France, Belgium, Sweden, Germany and Denmark.

Australian Atomic Energy Symposium

Senator W. H. Spooner, Minister for National Development in Australia, has announced that a major symposium on the peaceful uses of atomic energy is to be held in Sydney during the week June 2 to 6, 1958. Senator Spooner stated that the symposium is being sponsored by representatives of the universities, professional institutes, industrial firms, power authorities, Commonwealth and State Departments and the Australian Atomic Energy Commission. The symposium would be a forum for the discussion of technical and scientific aspects of the peaceful uses of atomic energy. Papers would be presented by overseas scientists as well as many Australian contributors. Particular attention would be given to the part atomic energy will play in the development of Australia. Senator Spooner said that several public lectures were being arranged. These would be given by a number of well-known authorities in the atomic energy field.

A special atomic energy exhibition was being organised to show developments in uranium mining, research into nuclear power and the industrial uses of radioactive isotopes. Excursions are to be arranged to the A.A.E.C. Research Establishment at Lucas Heights and to the University of Sydney and New South Wales University of Technology, where atomic-energy work is in progress. Additional information may be obtained from the Symposium General Secretary, A.A.E.C. Research Establishment, Private Mail Bag, Sutherland, New South Wales, Australia.

Canada's NRU Critical

The Canadian high-flux reactor NRU at Chalk River, Ontario, went critical towards the end of last year and, after a series of experiments at low power, the power has been raised; its rated thermal power is 200 MW. Cooled and moderated by heavy water, the reactor is fuelled with natural uranium and will provide large capacity experimental facilities for nuclear power development.

In addition it will be used for isotope production and the conversion of uranium 238 to plutonium. It is designed to accommodate all types of fuel assembly now under consideration and can be recharged while in operation. It is reported that both the U.S.A.E.C. and the U.K.A.E.A. are seeking the use of test facilities. It has five times the power of its predecessor NRX, which has now been working 10 years.

Industrial Group Officer for Generating Board

The Minister of Power has appointed Mr. Leonard Rotherham, M.Sc., M.Inst.Met., to be a full-time member of the Central Electricity Generating Board with effect from April 1, 1958. Mr. Rotherham is Director of Research and Development at the Industrial Group Headquarters of the United Kingdom Atomic Energy Authority, Risley.

The Human Element

Lock-out for Forced Labour

The report on the 40th session of the International Labour Conference held last June was published by H.M. Stationery Office last week (Cmnd. 382, price 2*s.* 3*d.*). The outstanding achievement of the conference was the adoption of the Convention for the Abolition of Forced Labour. This is the culmination of ten years of work both by the International Labour Organisation and the United Nations. The convention was adopted almost unanimously.

The final stage is ratification. This will be the crucial test of whether slavery masquerading as forced labour for economic development is to be abolished. It is at the ratification stage that vested interests can make their final stand, for they have more local control which can be exercised by influence and coercion than they dare mobilise at the international level. It will require such ratification however to remove slavery from the Middle East and from parts of Africa. This is a form of Afro-Asian collaboration which would be more to the point than the recent " anti-imperialist " resolutions passed at the Cairo conference where powerful interests were represented, if not Governments themselves.

Chandos Pay Plan Criticised

Lord Chandos's suggestion that wage agreements should incorporate a provision for regular annual increases of 2½ per cent. to offset rises in the cost of living index has been criticised by union leaders. Sir Thomas Williamson, general secretary of the General and Municipal Workers, described it as " an attempt to limit the scope of collective bargaining." He expressed more faith in the trade unions' ability to use collective bargaining " in a responsible manner " than in a proposal of the kind made by Lord Chandos, who was " far too ready to regard inflationary pressure as synonymous with trade union pressure."

Mr. Alan Birch, chairman of the T.U.C.'s economic committee, welcomed the implied recognition that wages must increase each year. The general and growing belief that a solution to the country's economic problems is to be found in freezing wages, he believed " both economically and socially bad." The continuous preaching of wage restraint tended to produce the opposite effect and to be looked upon by labour as a challenge. Mr. Birch suggested that much more good would emerge from a substitution for the " negative doctrine " of wage restraint " a positive dynamic drive for increases in real wages."

It is unlikely that trade union leaders will accept the removal of any item from collective bargaining on wages. In this they differ from their American colleagues who usually insist on a clause guaranteeing automatic increases matching rises in the cost of living index and also sometimes in a fixed percentage increase in real wages. This takes much of the wrangling out of the next contract negotiations and allows the parties concerned to concentrate on other matters such as guaranteed wages or length of the working week. British trade unions' jealous guarding of their collective bargaining rights may in fact weaken their bargaining position.

Labour Turnover

One of the papers in the October issue of *Occupational Psychology* has for its subject " Absence and Turnover in the Divisions of One Company, 1950 to 1955." In this paper Mr. John Crowther draws attention to the high correlation between rates of absence of workers, high labour turnover and changes in the demand for labour in the local market.

He emphasises that it is the change in the demand for labour which is significant. Thus, it is not so much that a high level of local employment makes for a high rate of turnover for a given factory but a change in the demand which seems to set up a desire for change in the workers' minds. This fact is, of course, of varying influence in labour turnover due to internal conditions in any one factory and the trend in the volume of employment. For example, if a factory has been expanding production and has taken on more workers it will tend to get a higher absence and wastage rate than before because new workers are always less prone to stay than those who have settled down and have integrated themselves within some group or unit within a factory.

It follows from this that the typical company has a very limited control over its labour wastage rate. It can mitigate the influence of changes of demand in the local labour market but in few cases will it be able to offset them completely by an enlightened labour relations policy. That does not mean that it should not have such a policy but that, if this investigation is correct, it should to content with half a loaf that is better than no bread.

Window-Dressing With a Difference

In the Midlands labour is still scarce and difficult to attract even into popular industries. The Villiers Engineering Company, Limited, at Wolverhampton is setting out on the most intensive recruitment drive in its 60 years' history to enroll a full night shift as well as find workers for increased day output. The company is going to gear production not only to record current requirements but also to the anticipated needs when the Free Trade Area comes into existence.

A shop has been taken in the middle of Wolverhampton, a double-fronted property in the main shopping centre. The windows display the various types of Villiers engine and a list of vacancies is also given. The shop is staffed by members of the company's personnel department. It is open every evening and on Saturday mornings for interviewing and enrolment.

The idea might not suit the recruitment policy of every concern but it shows refreshingly imaginative thinking and the same is true of the thought behind it. A company which is gearing its labour policy now for the Free Trade Area is thinking not only imaginatively about window dressing but also with commendable foresight.

Redundancy at Pinewood

The sacking of 360 employees by the Rank Organisation out of the 1,500 employed at Pinewood Studios was a dramatic reminder that the cinema is continuing to decline. This may be due to an " unreasonable and penal entertainments tax " as Rank claims or the inevitable result of a tendency—not to be ascribed entirely or even mainly to the influence of television—for people increasingly to enjoy entertainment in their own homes. The " unprecedented deterioration in attendances " in the past four months given by the Rank Organisation as the direct cause of the redundancy, certainly cannot be wholly attributed to the spread of television.

An inquiry published in *The Times* in new towns showed " not so much that television has stolen the screen from the cinema but that many

people to-day have new homes where the entertainment of their families and friends is more comfortable and pleasurable than anything they have known before." But outside the home the cinema is finding new rivals, particularly dance halls and other live entertainments in which people can participate. This is why in new towns spaces reserved for the building of cinemas are not being used for anything except car parks or stands for travelling circuses.

Meanwhile the number of cinemas that are closed grows apace: in 1952 it was 13, in 1954 33 and last year as many as 92. The size of the British Film Production Fund melts away and is now unlikely to exceed £2·5 million instead of the £3·75 million expected by the Board of Trade when it was set up. Doubtless something can and will be done by reducing or abolishing the entertainments tax paid by cinemas (it averages something over £2 million a month) but more will have to be found out before a cure is discovered—if one exists.

Vickers Scholarship Awards

The reputation of being a good training ground for engineers, even if they do not stay with the company in some cases, is something of which to be proud of. There may be occasions when the wastage rate to other concerns may seem somewhat high but such is the lot of those who these days lead the way in technical education.

Among those who have for long had a reputation for the quality of their training, Vickers as a group stand high. They have now announced their top scholarship awards for this year. Vickers nowadays offer an annual award at Cambridge for an engineering scholarship. It is made to one who has served with a company in the group for one year as an undergraduate apprentice and who undertakes to do a further year with the group after graduation. Three Vickers-Armstrong scholarships are awarded as well which are tenable at a college or university. There are also two Vickers-Armstrong supplementary awards made annually to the best undergraduate apprentices.

Maltese Cross

The threat by the prime minister of Malta, Mr. D. Mintoff, to take the island completely out of Britain's jurisdiction unless something was done to maintain full employment, has caught the British Government unprepared. For years now there have been fact-finding missions producing reports on what could or could not be done in bolstering up or creating local industry. The decision to close the naval dockyards—an inevitable consequence of a changing world—was misrepresented by Mr. Mintoff as being evidence of a callous lack of interest on the British Government's part. The Colonial Secretary replied with the familiar carrots of new industries and of a closer association between the two countries.

Malta's government clearly intend to use what bargaining power they have left—arising from their value as a base—to get economic support and investment. The earlier interest in integration within this country had the same objectives. So far, agreed schemes going forward include a £6 million project for an underground oil storage system—partly financed by NATO funds—and the construction of a civil harbour at the cost of £3 million. Recently Vickers and Smith Docks announced that they were sending a team to investigate the possibility of using the naval dockyards commercially.

But whatever plans exist or further plans are made, the prospect of unemployment faces the Maltese. The only solution—hinted at by the Colonial Secretary—is financial relief if, as a result of changes in defence policy, Maltese unemployment were to reach a higher level than unemployment in the United Kingdom.

Companies in the News

Medium Range Jet for B.E.A.

The interest of British European Airways in a short-medium range jet aircraft has aroused interest and speculation. The requirement itself has been known for some time and a number of companies have been reported as interested. The aircraft is to carry 80 to 100 passengers over ranges up to 1,500 miles at speeds of up to 600 m.p.h. and is required for service in 1963 or 1964. The machine is to be built as a private venture, the total development expenditure on which has been estimated to be in the region of £20 million.

Designs were originally submitted by Bristol, de Havilland, Vickers-Armstrongs, and A. V. Roe. Vickers withdrew owing to their heavy commitments on the development of the Vanguard and the V.C.10 for the British Overseas Airways Corporation. It was widely believed that the de Havilland proposal was favoured by B.E.A. on technical grounds and that the contract would go to this company. The official view—now widely supported—that some form of integration in the industry is essential, presents a further consideration.

The Hawker Siddeley Group and the Bristol Aeroplane Company announced last week a decision to form a new company with Sir Arnold Hall as managing director, capable of building the B.E.A. machine. The new company will be owned jointly by the two parent companies, with Hawker Siddeley owning 65 per cent. In making the announcement, the two companies pointed to the considerable financial resources available to back the new company. The combined assets of the two companies are in excess of £200 million. The design to be undertaken is the Bristol type 200, submitted to B.E.A.

The design work would be shared so that Bristol would undertake the structure, while the Hawker Siddeley group would be responsible for systems. Wind-tunnel and aerodynamic work would be shared according to the facilities available.

At the time of this announcement, no statement had been made by B.E.A. as to which of the two remaining competitors will receive the contract. However, enough has already emerged to show that technical considerations may not wholly govern the outcome. De Havilland take the view that the industry should not be forced to integrate at pistol point, and that sub-contract arrangements should be made after the project has been determined on technical grounds. There is much to be said for this view. Overseas markets are essential to commercial success, and performance is a prerequisite to securing these. However, with the present pace of aeronautical progress, performance can only be measured against that achieved by other aircraft at any given time. As little as two years' delay can mean failure in place of resounding success.

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Company with a Past

It is surprising, in view of the importance of industry in our society, how few good histories have been written of companies. For this no doubt the main reason is the lack of adequate documentation, particularly of the early periods when the founders were probably inarticulate artisans. Published on the occasion of the Ruston Centenary 1857-1957 and written by Mr. Bernard Newman, *One Hundred Years of Good Company* is a history of Ruston and Hornsby, Limited, which partly meets this need. But though it provides much interesting information concerning the foundation, amalgamation and growth of the company, it tells us little of the planning and personalities by which one of the outstanding engineering firms of this country has been built up.

As a history of technical change, the book tells in detail of the products produced by the company and its predecessors in peace and war, from the days when Richard Hornsby first went into partnership as an agricultural machinery maker in Grantham in 1815 and Joseph Hornsby joined a little firm of engineers in Lincoln in 1857. What is interesting is to note how these two typical organisations of the second stage of the industrial revolution were based first on the revolution taking place in agricultural methods and, later on, played their part in making Britain the workshop of the world, particularly by their exports to Russia, the East and South America.

Since then the range of the company's products has expanded enormously, but always two types seem to have predominated: machines for dealing with the soil or its products, whether they be ploughs, threshing machines or earth movers, and machines for the production of energy. Among the former it was their excavators which played a big part in the building of the Manchester Ship Canal; a business now carried out by the subsidiary they share with Bucyrus-Erie of America. Among the latter, while steam engines obviously dominated the early years, the company has always been in the van of new methods; the Akroyd Stuart compression ignition type of oil engine being patented by Seaman and Hornsby two years before Diesel took out his patents; while in more recent times the company has played a leading role in the development of the gas turbine. All these types of prime mover were capable of being made in an easily transportable and quickly installable form and so were very suitable for export to developing countries for installation in remote locations. To-day the company is undertaking research into the manufacture of small atomic energy generating plants.

Mr. Newman states that it was the collapse of their Admiralty business and the loss of their overseas markets after World War I which forced Seaman and Hornsby into amalgamation with Ruston, Proctor and Company; although there are hints that the directors had become too old and one would like to know why the two companies had such apparently different experiences during this period. The amalgamation, however, did not save the new company from suffering from the subsequent slump, for the total numbers employed fell from 13,000 at the end of the war to 4,750 in 1921. Nor did they avoid the consequences of the world crisis of the thirties and for 14 years the company made losses. Nevertheless, it survived to undertake an enormous variety of tasks in World War II, and to take advantage of the booming conditions that have existed in the engineering trade since.

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Shipping in the Doldrums

The volume of shipping laid up at British ports for reasons other than repair has now reached a 10 year record. There were 71 vessels amounting to 322,000 gross tons lying idle at the beginning of January. This represents an increase of nearly 100,000 tons on the month before and a 400 per cent. increase since the summer.

Foreign shipping laid up in the United Kingdom has also increased substantially. At the beginning of December there were 91,000 tons looking for cargo compared with 55,000 tons at the beginning of November. This means that altogether at the turn of the year there was about 412,000 tons of shipping laid up in the United Kingdom compared with a mere 32,000 tons at the beginning of 1957.

The reason for these depressing statistics is the continuing low level of cargo and oil tanker freight rates. Last autumn the index of tramp shipping freights reached levels which have not been seen since 1954. The average level of voyage charter rates was 157 (with 1952 as 100) and time charter rates were

Continuing Companies in the News

at 172·9 calculated on the same base year. Since December, 1956, however, both indices have slithered steadily until they reached the 80 mark in the autumn of 1957 and there is little sign of improvement since. There are already signs that the shipbuilding order books are in less buoyant state than they were a year ago and if the present level of freight rates persists it can only be a question of time before the outlook for new orders for cargo vessels is as depressing as it was in 1953 and 1954. It goes without saying that the present depressed state of the oil tanker freight market has taken the steam out of the oil tanker building boom and offers a stern warning to those engineering concerns which have filled their shops with sub-contract work for oil tankers.

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British Engines in Demand

The recent Smithfield Show high-lighted the extent to which Diesels made by F. Perkins of Peterborough have captured the agricultural market. Two of the new tractors had engines of Perkins make, the Allis-Chalmers D272 crawler, and the Massey-Ferguson 65, while the three cylinder engine of the Fordson Dexta is a joint effort of the two companies. The Massey-Harris 745 also uses a Perkins engine as do some other Allis-Chalmers machines.

Apart from tractors, Perkins engines are " standard " on seven different makes of combine. The German Claas and Lanz machines both use the L4(TA) engine. The same also is incorporated in the Arbos Bubba, the Swedish Thermaenius " Viking " and the Massey-Harris 780. The Belgian Claeys combine uses the P6(TA), and the Allis-Chalmers 60 all-crop harvester the P3/144(TA) models. In addition the new Perkins " Four 99 " engine, shown for the first time at Smithfield, is being fitted to the German Fahr combine, the Thermaenius 256 and the Austrian-built Epple Mobile self-propelled machine.

Other tractors using Perkins engines are: Bristol 25, the Australian " Champion," the German Guldner A3P. Also three Argentine combines, the Bernadine, Senor and the S. Puzzi. This list takes no account of the smaller stationary agricultural machines.

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Divers Components

The annual statements of several large suppliers to the motor industry, including Joseph Lucas, S. Smith and Sons, Triplex, Vokes, and others, indicate that very satisfactory trading conditions have prevailed over the past six months and are continuing. For some reason or set of reasons not at all easy to define, people are buying cars in this country and in most of our export markets despite high Bank Rate, credit restrictions, falling commodity prices and the like. The factors that determine the " buying waves " which have taken place since the war would be a most interesting field of study perhaps an ideal one for the use of the newer techniques of research, including both motivation research and operational research.

Both Joseph Lucas and Smith place great emphasis on the benefits they have derived from a policy of diversification. Mr. A. B. Waring, chairman of Lucas, said that the year under review (ended July 31) " was one in which they were more than usually thankful that our business was broadly based."

Smith are even more widely diversified, with their clocks and watches and instruments divisions. Like Lucas, their profits were up substantially and have now almost regained the level of the peak period three years ago. Their chairman, Mr. Ralph Gordon-Smith, drew the shareholders' attention to the growing capital requirements consequent on a policy of diversification.

Construction

GENERATING PLANT FIGURES FOR 1957

In their last year of operation the Central Electricity Authority installed new generating plant yielding an additional output capacity of 1,788 MW. This highly satisfactory result compares with the record figure of 1,797 MW achieved in 1956 and is nearly 3½ times the amount commissioned during the first year of public ownership to March 31, 1949.

The new plant commissioned in the power stations owned by the South of Scotland Electricity Board had an output capacity of 84 MW, making a total of 1,872 MW of generating capacity provided in the area of the former British Electricity Authority.

The additional C.E.A. plant, comprising 35 turbo-generators with an aggregate installed capacity of 1,903 MW and 41 boilers having an aggregate evaporative capacity of 15,950,000 lb. per hour, was installed in 28 power stations, Four of them are new stations in which plant was installed for the first time. The details are given in the accompanying table.

Of the 41 new boilers, two having an aggregate evaporative capacity of 1,100,000 lb. per hour were oil-fired. In addition, at four existing coal-fired stations eight boilers with total steam capacity of 2,860,000 lb. per hour were converted to oil-firing.

Speed of construction was improved during the year, particularly with the commissioning of the first 60 MW set at Rogerstone power station exactly three years after work started on the virgin site, the second and last set being brought into service three months later. Another outstanding achievement was the commissioning during the year, by three different turbine and two different boiler manufacturers, of five 100 MW units all of 1,500 lb. per sq. in. steam pressure, which can be regarded as prototypes of the larger generating units that will come into service during the next five years.

The peak demand met by the Authority during the year was 19,311 MW, which was supplied at full voltage and frequency at 5 p.m. on Monday, December 16. This was 1,643 MW above the peak load met at the beginning of the year, and was about 125 per cent. above the peak demand of 8,607 MW met in England and Wales in the year before April, 1948.

The amount of generating plant to be commissioned in 1958 will be substantially less than in recent years because of the capital investment cuts imposed on the industry two years ago. As from January 1 the Central Electricity Authority ceased to exist, its functions being taken over by the newly-formed Electricity Council and the Central Electricity Generating Board under the chairmanships of Sir Henry Self and Sir Christopher Hinton, respectively.

Power station	C.E.A. Division	Turbo-generator plant Installed capacity, MW	Boiler plant Capacity, 1,000 lb. per hr.
Steam Plant:			
ACTON LANE B	London	2 × 30	2 × 240
BARKING C	London	—	1 × 540
BOLD A	N. West.	—	1 × 300
BRIGHTON B	S. East.	1 × 60	2 × 320
CARMARTHEN BAY	S. Wales	—	1 × 240
CASTLE DONINGTON	E. Mid.	3 × 100	2 × 830
CHADDERTON B.	N. West.	1 × 60	2 × 360
CONNAH'S QUAY	N. West.	1 × 30	1 × 300
DEPTFORD EAST H.P.	London	1 × 52	—
EAST YELLAND	S. West.	1 × 31	1 × 180
FERRYBRIDGE B	Yorks.	1 × 100	1 × 760
GOLDINGTON	East.	1 × 30	1 × 300
HACKNEY B	London	1 × 30	1 × 300
HAMS HALL C	Mid.	3 × 60	3 × 550
HUNCOAT	N. West.	1 × 30	1 × 305
LINCOLN	East Mid.	2 × 20	4 × 120
MARCHWOOD	South.	1 × 60	1 × 550
MEAFORD B	Mid.	2 × 60	1 × 515
MEXBOROUGH	Yorks.	2 × 30	3 × 180
NOTTINGHAM H.P.	East Mid.	1 × 60	1 × 300
OCKER HILL	Mid.	—	1 × 180
PORTISHEAD B	S. West.	2 × 65	3 × 300
ROGERSTONE	S. Wales	2 × 60	2 × 550
SOUTH DENES	East.	1 × 60	1 × 550
TILBURY A	East.	2 × 60	2 × 540
WAKEFIELD B	Yorks.	1 × 60	1 × 550
WILLINGTON A	East Mid.	1 × 100	1 × 830
27 stations including 4 new stations	11 Divisions	34 turbo-generators having an aggregate installed capacity of 1,893·5 MW	41 boilers having an aggregate installed capacity of 15,950,000 lb. per hr.
Hydro Plant:			
DOLGARROG	N. West.	1 × 10,000	—

Note.—The power stations for which the name is printed in large caps are new stations; in these plant has been commissioned for the first time in 1957. The others are existing stations to which extensions have been made.

PANELS FOR MOVABLE WALLS

A structural panel which is claimed to possess considerable fire resistance, good sound-reduction qualities and good thermal-insulation properties has now been added to the existing range of panels for use in connection with movable walls produced by Holoplast Limited, New Hythe, near Maidstone, Kent. The new panel material is the Holoplast " 80," which, unlike the older " 75 " and " 90 " panels, has no interior webs. Instead, it has a solid core of Viculite, a proprietary material consisting of exfoliated vermiculite. The two outer sheets of the panel have surface textures comprising either a glossy or eggshell stoved-enamel finish or a satin or eggshell Decorplast finish.

As is the case with the 75 and 90 panels, the 80 panel can be incorporated in the firm's standard aluminium extrusions to build up complete movable-wall installations. The new panel is 1⅛ in. thick and its standard width is 4 ft.; the standard lengths are 4, 6, 8, 9 and 10 ft.

In laboratory fire-resistance tests, carried out on a scale of about 12 in. by 12 in., and as nearly as possible to the temperature-time conditions stipulated in B.S. 476 : 1953, a rating of about two hours is stated to have been obtained. Sound insulation tests so far carried out indicate that the new panel provides a reduction factor having a minimum of the order of 30 decibels.

The standard stoved-enamel finishing colours available are cream, green, pink, French grey, blue, and white, but other colours can be produced to suit clients' requirements. Five Decorplast surface patterns, and up to 14 colours are also available as surface finishes for the outer sheets.

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A study undertaken at the Hydraulics Research Station of D.S.I.R. has substantially reduced the length of the viaduct thought to be necessary to carry the London to Yorkshire motorway over the River Trent and its flood plain, 10 miles up-stream of Nottingham. The possible saving in construction costs is put at £800,000. A model of the area, representing an area of about 5 sq. miles, indicated how advantage could be taken of some low ground and the most economic number, span and disposition of flood arches in the viaduct; the number proved to be about half that originally expected.

PRE-CAST CONCRETE JETTY

Novel Techniques For Heavy Duty Construction

A JETTY of pre-cast prestressed concrete has recently been finished on the Thames to accommodate ocean-going colliers of 14,000 tons displacement. These vessels have a draught of about 28 ft. when fully loaded and the jetty has been taken as far into the river as will allow the berth to be dredged to 23 ft. below LWOST (low water, ordinary spring tides). The unloaders —three cranes, each of 8 tons capacity and a maximum handling rate of 250 to 300 tons an hour—are sufficient to ensure that a Liberty ship berthed on the flood tides can be sufficiently lightened to reduce its draught to less than 23 ft. by first low water; this means that some 4,000 tons of coal will have to be shifted within 8 hours. The main contractors were Holloway Brothers (London) Limited, and the consulting engineers for the jetty Sir William Halcrow and Partners, Westminster. Two principal sub-contractors were involved in the production of the pre-cast concrete units: Costain Concrete Company, Limited, who made the foundation cylinders, and Shockcrete Products Limited the prestressed beams.

The cranes, which weigh 230 tons each, are able to lift their full load at 94 ft. radius and, in the worst condition, each wheel of the three-wheel bogies could impose a 50 ton load on the jetty rails. These wheel loadings and the rail gauge, together with the types of ships which would use the berth, formed the basic data for the design of the new jetty. It has been sited clear of the old jetty to allow the depot to continue working and every effort has been made to impede as little as possible the flow of the river; columns are widely spaced in the approach and particular care has been taken in the alignment of the jetty head. It is hoped that, with the removal of the old timber jetty, much of the mud held up on this section of the river will disperse. The alignment of the jetty approach is such that there is a straight rail connection between the main sidings and the jetty head and a minimum radius of 150 ft. has been adopted for all the new permanent way, to meet the expected increase in capacity of British Railways mineral wagons. The jetty decking is designed to take the 25 ton mineral wagons or, alternatively, a 30 ton lorry. For the benefit of lorry traffic, the rails are all flush and a turntable (22 ft. 6 in. in diameter) has been provided at the end of the jetty.

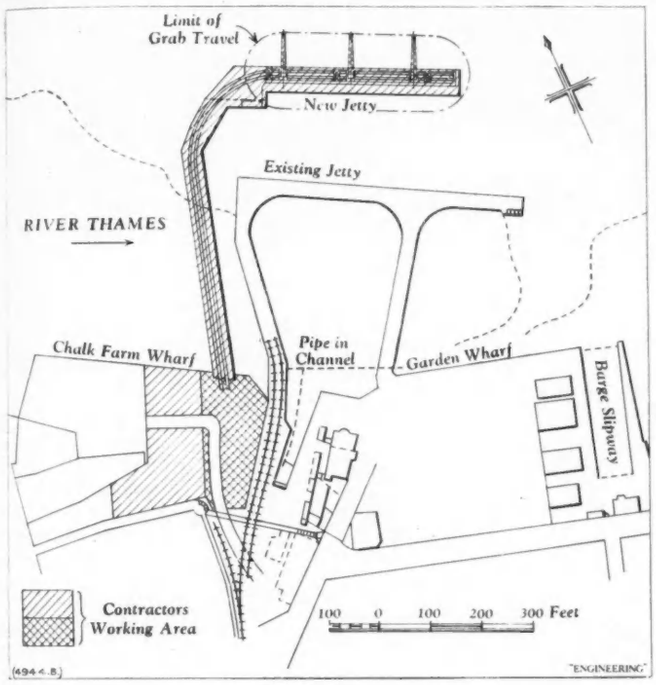


Fig. 1 Site plan, showing location of Wm. Cory's new jetty for ocean-going colliers. The head of the jetty is sited as far out into the river as the Port of London Authority would permit.

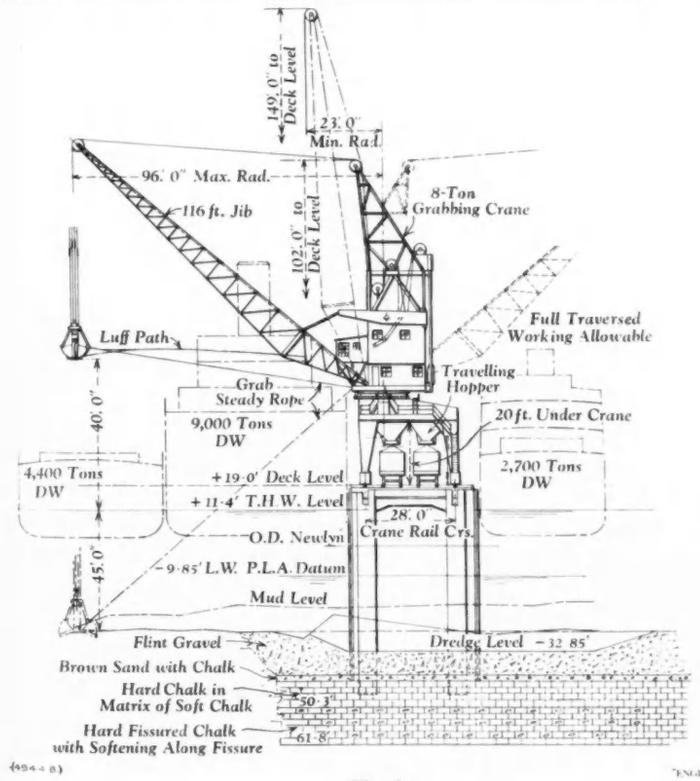


Fig. 2 Cross-section of jetty, showing location and reach of the cranes. It is hoped that the open spacing of the piles will allow the dispersal of the mud now held up by the existing wooden jetty.

LAYOUT AND PILING

The jetty is L-shaped in plan. The straight approach arm consists of eight bays of 50 ft. span and the jetty head comprises 22 bays of 25 ft. span. At the connecting corner there are two lines of standard gauge railway track at radii of 150 and 160 ft. Deck slab widths are 34 ft. for the approach and 38 ft. 3 in. for the head, with an enlarged portion approximately 75 ft. by 70 ft. at one side of the junction.

The foundations for the jetty consist of 72 prestressed concrete cylinders, varying in length between 35 and 65 ft. Each cylinder is built up of a number of hollow pre-cast concrete units all of which have an outside diameter of 6 ft. and a length of approximately 5 ft. The concrete shell is 6¼ in. thick and constitutes the main structural portion of the cylinder. The cylinders were assembled vertically in a special berth built against the wharf wall.

After assembly, the units were post-tensioned together using the Lee-McCall system with 16 " Macalloy " bars of 1⅛ in. diameter spaced symmetrically around the shell. The bars were

Fig. 3 Partly constructed approach arm showing the cylindrical piles, pre-cast soffits of the main beams and deck stringer beams with the protruding shear connectors to the deck slab.

Fig. 2 Fig. 3

threaded through 2 in. diameter cored holes and, after stressing, grouted with colloidal grout.

To facilitate sinking, each cylinder was fitted with a cast-steel shoe and the end nuts on the prestressing bars were located within the ring of the shoe which was filled with mortar prior to launching. The weight of the completed 65 ft. hollow cylinders was about 40 tons each but they were kept upright while being floated into position, pitched and sunk. They were founded in a chalk stratum consisting of hard white chalk in a matrix of soft chalk and flints, overlaid with a thin layer of sand and chalk, and some flint gravel. The open-ended cylinders were sunk by grabbing and loading with kentledge blocks.

After each cylinder had been sunk to its final level, silt and mud were removed by a diver preparatory to the placing of a concrete plug. The first section of the plug was formed by placing gravel under water in the bottom of the cylinder, approximately 20 ft. deep, and injecting " Colgrout " at the bottom of the gravel. The cylinder was then pumped dry and filled with low-grade concrete.

JETTY SUPERSTRUCTURE

In the approach arm the foundation cylinders, 25 ft. apart and at 50 ft. longitudinal centres, are connected by *in situ* concrete main cross beams which have a pre-cast prestressed soffit. Stringer beams, also pre-cast and prestressed, span between main beams and the whole structure is integrated by a 7 in. reinforced deck slab cast *in situ*. The main cross beams are designed to act in conjunction with the cylinders to form a series of rigid portal frames. Except in the end bays of the approach arm, and in two bays of the junction between the head and approach arm, the stringer beams are all seated on pre-cast concrete plinths. They are of a modified I-section with solid end blocks and are 48 ft. 0½ in. long with a tolerance of plus zero, minus ½ in. To transmit the horizontal shear forces the top surfaces of the beams have shear connectors of ½ in. diameter bar hoops at 8 in. centres.

The pre-cast soffits of the main beams will be subject to the action of waves at high tide and high quality prestressed concrete at this location is therefore a definite advantage. The use of pre-cast soffits considerably reduced the amount of formwork required over water and provided a brace for the cylinder piles until the stringer beams were in position and the main beams cast.

The jetty head is of construction similar to the approach except that the stringer beams span only 25 ft. and the two external stringer beams are replaced by larger crane beams. Few of the pre-cast units exceeded 7 tons in weight.

A screed of mass concrete has been placed over the length of the jetty to produce a finished deck flush with the running surfaces of the crane and railway tracks. Electrical services, aircraft runway lighting, and water supplies for the vessels are contained within the deck screed.

Arrangements for fendering on the riverside face of the jetty include a novel and ingenious shock-absorbing device. Steel box piles driven into the chalk are supported at their upper end by flexible units consisting of two 21 in. diameter rubber discs, approximately 6 in. thick, bonded to mild steel plates.

To ensure that the cranes can maintain a continuous discharge cycle without waiting for empty lorries or railway wagons, three double-loading hoppers have been provided, running on the crane tracks; each has a 50 ton capacity.

The jetty was built for William Cory and Son Limited at their yard on the River Thames at Erith. In addition to the consultants and civil engineering contractors already mentioned the following contributed to the installation. The Clyde Crane and Engineering Company built the cranes, the aluminium jibs of which were obtained from Head Wrightson Aluminium Limited; loading hoppers were bought from Tee-Side Bridge and Engineering Works Limited; and the electrical installations were undertaken by Crompton Parkinson Limited.

Fig. 4 Sinking one of the hollow cylindrical piles which were floated into position after being assembled vertically in the tower to be seen against the wharf wall behind the new jetty.

Fig. 5 The finished jetty, with cranes and travelling hoppers in working order. The three cranes have aluminium jibs.

CONTINUOUS PLATE GIRDER BRIDGE WITH 300 FT. SPAN

One of the largest continuous plate-girder bridges ever to be constructed, the Oak Street bridge in Vancouver, was opened to traffic during 1957. The bridge provides four lanes of traffic (48 ft. between kerbs) over a total length of 710 ft., excluding approaches; there are three spans, two of 205 ft. and a centre span of 300 ft. Full details of the bridge and of the Middle Arm bridge, a related project, are given in the *Engineering Journal* for December, 1957, of the Engineering Institute of Canada, by Mr. L. Osipov, the chief designer of Phillips, Barratt and Partners, consulting engineers, of Vancouver, who were responsible for the design.

Before selecting the three-span continuous riveted girders with a plate deck, a number of other types, each of three spans, were considered but were found to be more expensive. These included:—

(1) A continuous deck truss;
(2) A continuous modified through truss;
(3) A continuous riveted deck plate bridge carried on four girders; and
(4) A reinforced concrete box girder with a centre suspended steel span of 150 ft.

The first of these was not so costly on its own account as the chosen design but it required higher approaches so increasing the overall cost of the full project. The selected design was also thought to have the best profile.

To obtain economy in the depth of the plate girders, a compromise had to be reached between the rigidity of the span plus the resultant saving of steel in the flanges (which favoured deep girders) and the saving of steel in the web plus fabrication and erection costs, favouring a shallow girder. This compromise resulted in a 6 ft. depth at the exterior supports, 21 ft. at the interior supports, and a 10 ft. minimum depth in the centre span. The upper flange was made to follow the flat vertical curve of the roadway and the lower flanges elliptical curves.

Flange make-up followed European practice and used two heavy angles (8 × 8 × 1) and fairly thick and wide cover plates; the flanges were ¾ in. plates by 34 in. wide throughout. The *Specification for Highway Bridges*, 1951 (*B.C.*) was used for the design of the web plate where the spacing of the vertical stiffeners and the shear stresses governed the design. All stiffeners were spaced at 5 ft. Where the unsupported depth of the web plate controlled the design, horizontal stiffeners were provided and the webs proportioned by the method outlined in the American Society of Civil Engineers' paper (No. 2120) entitled " Theory of Elastic Stability Applied to Structural Design," except that a factor of safety of 1·8 was used instead of 1·4 as suggested in the paper.

Lateral K-bracing, to transmit the wind forces to the piers, was provided in the planes of both the top and bottom flanges, and cross frames connecting the lateral bracing system were provided every 20 ft. Silicon steel was used for all flanges and web sections; stiffening, bracing and deck members (trussed beams) were fabricated from a medium steel.

CONSTRUCTION OF HYDRO-ELECTRIC POWER STATIONS

Speed and Economy Obtained by Mechanisation

A document, which has been issued by the United Nations, Geneva, contains the results of a study undertaken by the Committee on Electric Power of the Organisation for Economic European Co-operation (O.E.E.C.) on the prospects of reducing the building costs of hydro-electric power stations and on the effect of mechanisation in bringing that end about. It is based on 43 reports, which were prepared by rapporteurs in 15 countries and were presented at a meeting in Geneva in November, 1956. The document is available in English.*

These reports are divided into three main sections, namely: the characteristics of stations constructed in various countries since the second world war; on how construction has been and can be made more efficient by rational organisation and mechanisation; and on the use of constructional methods requiring less cement, steel and manpower. Factual summaries are given of each report and these are preceded by shorter accounts covering the salient points brought out in each group. The result is a great deal of interesting information, although it must be pointed out, and is indeed admitted that, as regards financial arrangements, costs, time of construction and organisational methods, comparison is difficult, and perhaps unwise, owing to the different conditions which exist in the various countries.

The time of construction, it is pointed out, depends not only on the degree of mechanisation, but on topographical, geological and climatic conditions and on the possibility of linking the site to the road network. Another relevant factor is the need to complete a project quickly in order either to improve the power situation or to save money when the interest rates are high. In Portugal, for instance, the increasing demand for power has led to the construction time for stations being reduced to about 2½ years, a result in which mechanisation has played its part.

In Italy, to mention a particular example of what seems to be the general experience, the chief advantage of mechanisation is that it renders possible the carrying out of work which would otherwise be impracticable. This is particularly true where excavation has to be effected in poor rock. In fact it may be concluded that the considerable advances that have been made in hydro-electric power station construction since the end of the second world war have resulted in savings in time and materials.

The reports on how construction has been, and can be, made more efficient by better organisation and mechanisation contain a large amount of technical and economic data on productivity and construction costs, although, as has already been pointed out, these are not always comparable. It is a general opinion that excavation can be carried out more quickly and more cheaply with heavy than with lighter machinery; such an example is the tail race for the Utanen power station on the River Oulo in Finland. This is 11·5 km. long and as much as 18 m. deep at certain points, and its construction necessitated the removal of 7 million cubic metres of spoil, of which 4 million cubic metres was rock. By the use of excavators with buckers of 4·5 and 6 cubic metres capacity, 4 in. rock drills and 8 and 10 ton trucks it was, however, possible to complete the work in two years, the record monthly volume excavated being 360,000 cubic metres and operations being carried on in temperatures as low as − 35 deg. C.

Data are also given regarding the alluvial filling of 81 m. high dams at the Mingechaursk station on the Kura in Russia. These justify the conclusion that, given suitable local conditions, the use of hydraulic methods of earth moving in large-scale operations results in a saving both in time and cost.

Seven reports deal with new methods of preparing the ultra-fine sand used in the manufacture of concrete and the improvements thereby obtainable, the mechanisation of the preparation of the aggregates and of concreting during the winter. Six others describe the use of mechanisation in tunnelling and shaft driving. In driving a 4·6 km. tunnel for the Volturno-Garigliano scheme in Italy it was found necessary, while the work was in progress, to adopt more modern equipment for drilling and extracting owing to the nature of the rock. It was therefore possible to compare the two methods of mechanisation. It was then found that a 60 per cent. increase in the rate of advance and a 28 per cent. reduction in the man-hours per cubic metre of rock were obtainable.

At the Kuibishev power station in Russia it is planned to instal the turbines at intervals of 20 days by setting up the fixed parts as soon as the foundations are ready. Construction time and cost in Austria are being reduced by the use of prefabricated reinforced concrete units for revetment of dams. These units have been found more satisfactory than natural stone masonry, as it enables complex components to be manufactured by specialists and working time on site to be reduced. It has been found in Sweden that the use of hydraulically operated sliding forms offers certain advantages over other alternatives to the costly method of placing concrete in fixed wooden shutters, as raising can be effected at every lifting point at the same speed.

* *The Mechanisation in the Construction of Hydro-Electric Power Plants*. United Nations, Geneva [3*s*.].

SUSPENSION PIPE-BRIDGE

A novel form of suspension pipe-bridge is shown in the accompanying illustration. Few facts are available about the bridge but its structural form, with the Y-supports, wire cables and suspenders, is readily appreciated. The span would appear to be just under 200 ft.

The bridge carries over the River Danube a pipeline which has been laid to convey natural gas to Vienna and Lower Austria. The work is part of a project being undertaken by the Austrian Mineral Oil Organisation and, by the beginning of 1958, it was expected that gas would be piped over the bridge from Zwerndorf to the gas-works at Simmering and from there to industrial works in Vienna.

PORTE COCHÈRE 1957

The many of our readers who attend receptions and dinners at the Savoy Hotel will benefit from the new *porte cochère* at the Embankment entrance. Modern in choice of material and line, the reinforced concrete canopy is a deliberately airy contrast to the more solid structure to which it gives entrance. Elegant and functional, the canopy is of sufficient size to provide cover for several cars simultaneously. The architect is Mr. Eric Janes. Incidentally, a *porte cochère* is intended for carriages; a *portico* is for people arriving on foot—so says the little brochure distributed when Sir Charles Norton, Mayor of Westminster, performed the opening ceremony.

Management

THE ENGINEERING INDUSTRIES

What The Future Holds for

AGRICULTURAL MACHINERY

The first article in this series appeared in our issue of January 3 and dealt with the effects of exports, raw materials, and wages on the engineering industries as a whole. In this article forecasts are given for five industries—agricultural machinery; locomotives and rolling stock; machine tools; textile machinery; and coal and electricity. Reports on other industries will be published in succeeding issues of ENGINEERING.

Agricultural machinery had a bad year in 1956, and in this series last year it was forecast that 1957 would possibly show a modest improvement. The figures for total production and production for export of agricultural machinery shown in the graph suggest that this modest increase in output has in fact taken place. To some extent, however, these figures are misleading since they show output for years ending in June and, as a result, the improvement of the position that has taken place in 1957 is somewhat masked by the production in the last two quarters in 1956, which still lagged appreciably behind the output in the corresponding period in 1955. From the end of 1956, however, total output of agricultural machinery, including tractors, rose steadily, and output for the first six months of 1957 in fact totalled 17 per cent. more than in the corresponding period of 1956; output in the second quarter of 1957 exceeded by 12 per cent. even that for the corresponding period of the record year of 1955. The improvement which has actually taken place is therefore substantial.

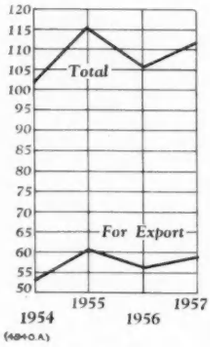
In considering the significance of these figures, two facts are of major importance. The first is the very high export ratio of the agricultural machinery industry as a whole; for the last four years this ratio has been about 53 per cent. The second factor is the outstanding importance of tractors as compared with all other types of agricultural machinery. In the case of agricultural tractors, rather over 70 per cent. of total output is exported. Moreover, in the first nine months of 1957, exports of agricultural tractors accounted for more than 75 per cent. of total United Kingdom exports of agricultural machinery. The performance of the agricultural machinery industry, therefore, depends to a large extent on that of the tractor manufacturers, who themselves depend on their success in export markets.

What actually happened in 1957 was that the tractor manufacturers made a very great improvement over their performance in 1956, while the remainder of agricultural machinery suffered if anything a slight decline. This decline is particularly apparent in exports, the total for the first nine months of 1957 amounting to £13·2 million, compared with £14·3 million for the corresponding period of 1956. Tractor exports, however, for the same period rose to £42·8 million from £34·2 million, an increase of about 25 per cent. While the overall position is therefore encouraging, this is entirely due to increased tractor production and sales.

The relatively poor performance of the British tractor manufacturers in 1956 was due to two principal causes. The first was the extensive reorganisation taking place in the tractor manufacturing industry, which seriously disrupted production, and the second was the encroachment of German manufacturers into traditionally British markets. Both of these factors have been removed in 1957.

The reorganisation which took place in 1956 was intended to make way for greatly increased production of new models, and was largely completed during that year; its rewards have been reaped during the past year. Even more satisfactory, in view of the possibility of overproduction, is the success which British manufacturers have achieved in the face of German competition. This again can be explained by the different organisation of the industry in Britain and Germany. In this country, tractor manufacture is very largely concentrated in two companies, Massey-Harris-Ferguson (through the Standard Motor Company) and the Ford Motor Company. Between them, these two companies are estimated to account for about 80 per cent. of United Kingdom tractor production, and very nearly this proportion of British exports.

Total production of agricultural machinery in the United Kingdom during the last four years.



In contrast, the German manufacturers consist of a large number of comparatively small units but in the tractor field, volume production is of immense importance, and owing to the large scale production by British manufacturers, their costs compare very favourably with those of their German competitors. In fact, Massey-Harris-Ferguson have achieved considerable success in exporting tractors to Germany itself, where it is estimated that they have obtained as much as 20 per cent. of the total market.

Australia and New Zealand together still account for by far the largest proportion of United Kingdom exports of tractors. The position in this market also was confused in 1956, owing to import restrictions imposed by the Australian Government. With the relaxation of these restrictions in February, 1957, exports to Australia have again jumped to a very high figure. For the first nine months of 1957 they amounted to £6·7 million compared to only £3·9 million and £4·6 million for the corresponding periods in 1956 and in the record year of 1955.

Exports to Europe have in the main increased, with the single exception of France, where German competition still remains severe. Exports to dollar countries have similarly increased encouragingly. Exports to the United States have risen comfortably, while exports to Canada have nearly doubled the figures for 1956. Perhaps one of the most encouraging features is the steady increase of tractor exports to Germany. Though at present a small market, the position in the Middle East is not so encouraging, and it is probable that German competition is being felt more severely there than elsewhere.

German manufacturers in 1956 succeeded in increasing their exports by about 35 per cent. This was at least partly achieved with the help of an export credit organisation, sponsored by the German Government, which enabled German exporters to offer better credit facilities than their competitors. The help from this source has been considerably smaller during 1957, and this, in conjunction with the introduction of improved models by the leading United Kingdom manufacturers, appears to have turned the scale. Perhaps the biggest single market for British tractors which has declined appreciably in 1957 is Finland, where for the first nine months of the year exports amounted to £667,000, compared with over £3 million in the same period of 1956. This has been due to the Finnish sterling diffi-

TABLE I *United Kingdom: Exports of Agricultural Tractors and Machinery*

—	Quantity			Value (£1,000)		
	1955	1956	1957(*a*)	1955	1956	1957(*a*)
Agricultural tractors:	No.	No.	No.			
Under 10 belt h.p.	9,754	6,519	5,712	1,097	845	781
10 to 25 belt h.p.	26,870	16,435	6,597	9,968	6,108	2,767
25 to 36 belt h.p.	24,720	30,869	58,641	10,974	14,205	28,221
36 belt h.p. and over	43,299	35,974	39,110	21,898	18,531	20,923
Total: Agricultural tractors	104,643	89,797	110,060	43,937	39,689	52,692
Agricultural machinery:	Cwt.	Cwt.	Cwt.			
Mechanical ploughs	176,358	144,059	171,176	1,926	1,701	2,147
Other machinery for soil preparation and cultivation	278,341	241,280	265,487	3,414	3,181	3,603
Hay and grass mowers (incl. mowing attachments to tractors) other than rotary blade types	52,135	62,579	52,141	919	1,071	990
Combine harvesters—threshers	143,918	139,444	199,560	2,696	2,660	3,595
Other harvesting, threshing and sorting machinery	198,336	192,673	179,379	3,121	3,156	3,171
Dairy machinery	36,405	38,857	27,464	2,009	2,373	1,703
Lawn mowers	139,723	119,151	126,069	2,034	1,691	1,618
Sheep shearers and dipping machines	4,259	3,197	2,767	296	241	236
Other descriptions	85,559	77,616	72,855	1,349	1,426	1,316
Total: Agricultural machinery	1,115,034	1,018,856	1,096,898	17,764	17,500	18,379
Grand total	—	—	—	61,701	57,189	71,071

(*a*) Nine months annual rate.

TABLE II *United Kingdom: Exports of Agricultural Machinery, other than Tractors, by Country of Destination*

—	Value (£1,000)		
	1955	1956	1957(*a*)
Australia	2,992	2,484	1,409
New Zealand	1,023	1,172	1,414
Union of South Africa	1,068	895	859
Canada	449	421	447
Other Commonwealth countries	1,984	1,929	1,776
Irish Republic	1,985	1,464	1,585
Sweden	529	367	413
West Germany	404	531	387
Netherlands	467	569	617
Belgium	282	304	441
France	516	1,433	2,229
Other West European countries	1,828	1,368	1,133
United States of America	591	633	700
Other foreign countries	3,638	3,932	4,969
Totals	17,762	17,502	18,379

(*a*) Nine months annual rate.

culties which it is to be hoped are only temporary.

In the short term view, the Commonwealth, Europe, and the United States remain the largest markets for agricultural tractors. In the long term, the best prospects outside the Commonwealth and Europe must lie in underdeveloped areas. The contrast between the degree of farm mechanisation in the advanced and the underdeveloped areas is immense. It is estimated that the number of tractors in use in the world, excluding Russia, is about 7·6 million. Nearly 4½ million of these are in the United States and nearly 2 million in Europe. It is estimated that there are only 70,000 tractors in the whole of Asia, nearly half of which are in Turkey, while, in Africa, there are about 152,000, half of which are in South Africa. There is clearly a very large market for development here.

In this connection, there have been rumours of large-scale imports by China. Towards the end of 1956, figures reached the Press suggesting that the Chinese Government wished to purchase something of the order of 1·4 million tractors over the next few years. To some extent this figure is misleading, since the Chinese require mainly smaller types of up to 15 h.p., but this is still a very large market. Trial orders have been shipped out by a number of European countries on a comparatively small scale, but no definite decision appears to have been reached. It appears likely, however, that even supposing that the Chinese would prefer to buy Russian tractors, they will in fact buy their requirements, if they materialise, in Europe, since the Russian capacity is already extended by that country's own very large demand.

It has frequently been suggested that the United Kingdom already possesses the maximum number of tractors that the market can absorb, and that home demand in the future will be governed solely by replacement requirements. To some extent this is true, although the deliveries of tractors to the home market have increased somewhat this year. In the main, however, it almost certainly remains true that any further expansion of tractor sales must be in the export market.

A parallel may possibly be drawn between the present position in the United Kingdom and that which obtained in 1951 in the United States. There, tractor production reached its peak in 1951 when over 777,000 tractors were produced. Since then, with the home market saturated, production and sales have declined steadily, output reaching only 273,000 last year. As the United States have not succeeded in maintaining their exports (only 52,000 United States tractors went abroad in 1956) this has meant an appreciable contraction in the United States tractor industry. It must, to a great extent, be due to the high production costs in the United States, and it accounts for the general trend of United States manufacturers to move out of high-cost producing areas, and to set up production units in low-cost areas, such as the United Kingdom. This trend continues, the obvious example being, of course, Massey-Harris-Ferguson in this country, although International Harvester have now moved up to the third position so far as scale of production in the United Kingdom is concerned. Caterpillar's tractor factory should be in full production early this year.

The outlook for British tractor manufacturers in 1958 is therefore promising. Production is rising to new record levels and, with new models being offered, the prospects for success in the export markets are considerable.

Compared to tractors, the agricultural machinery industry did less well in 1957. With a few exceptions, exports in general declined. One of the exceptions was France which, in the first nine months of 1957, took roughly double the value of agricultural machinery other than tractors than for the corresponding period in 1956. The decline was particularly marked in the case of Australia, where exports were roughly halved. Again it is probably in the underdeveloped areas of the world that the best long-term prospects lie, and it is perhaps significant that during 1957 there was a very marked increase in exports to "other foreign countries," suggesting that the agricultural-machinery industry is alive to the situation.

Companies offering complete farming systems show up to advantage in this situation. A particular example last year was the large orders received from Jugoslavia by Massey-Harris-Ferguson for 2,200 tractors and 12,500 implements and accessories. On top of these substantial orders was an order for 240 large self-propelled combine harvesters.

In the case of the bigger manufacturers of agricultural machinery generally, the value has been shown of extensive reorganisation and improvement of production techniques, together with the introduction of new and improved models, even at the expense of labour troubles and temporary dislocation of production. This perhaps provides a pointer to other industries facing the consequences of the European Common Market and Free Trade Area. The inconvenience during 1956 certainly hurt the manufacturers, but the rewards have been reaped in 1957. The fact that these rewards have been reaped by an industry in which production is concentrated to such a great extent in the hands of a few large manufacturers is suggestive of the type of measures necessary to meet the more severe competitive conditions which will come into force within the next year or two. The agricultural machinery industry in general should be in a strong position to meet the challenge.

What the Future Holds for

LOCOMOTIVES AND ROLLING STOCK

The transition from steam to Diesel and electric traction and the doubts concerning the amount of finance the Government is prepared to provide in the future for the British Railways modernisation plan continue to dominate the locomotive building industry. The first factor presented a reorganisation problem for some manufacturers in 1956, from which they are just recovering. The recent curtailment of capital expenditure raised doubts as to the future of the modernisation plan. In point of fact, it appears that the total capital expenditure by the Transport Commission is to be limited for the next two years to an annual figure of about £170 million, of which approximately £135 million will be spent on rail transport. The figure of £135 million may be allowed to rise to £140 million in 1959.

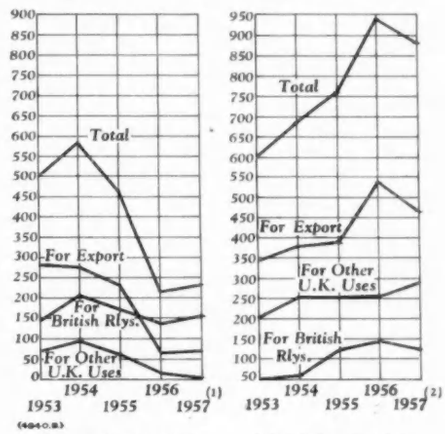
Superficially, this figure is in line with the original estimates for this stage of the railway modernisation plan; however, with rising costs the original estimate of £1,200 million has now been upgraded to about £1,500 million, an increase of 25 per cent., so that holding the annual expenditure steady at the original estimate means in fact a 20 per cent. cut in real terms. It has also been emphasised that in view of the long delayed modernisation of the British arterial road system any cuts which are made should fall on the railways rather than on road improvement. The present situation in fact leads to some considerable uncertainty so far as the locomotive builders are concerned. On the other hand, with large orders for British Railways already placed and the assurance of larger to come, the locomotive builders now have support in the home market which has in the past been largely denied them.

June, 1957, saw the delivery of the last main-line steam locomotive to be built for British Railways and the delivery of the first main-line Diesel locomotive to be handed over under the modernisation plan. The latter was the first to be delivered of the 141 to be built under the British Railways pilot scheme to determine the best locomotives for development. It was expected that by the end of 1957, 50 Diesel main-line locomotives would have been delivered, and 100 should be delivered during 1958. In addition, the number of Diesel shunting locomotives in use in October, 1957, was about 550 and the

TABLE III *United Kingdom Exports of Locomotives and Rolling Stock*

	Quantities (tons)			Value (£1,000)		
	1955	1956	1957(*a*)	1955	1956	1957(*a*)
Complete locomotives:						
Steam	22,545	12,714	9,925	7,000	4,091	3,772
Others	17,274	19,743	13,715	10,636	13,019	8,908
Railcars	1,164	1,095	323	1,001	962	233
Railway carriages, complete	5,685	7,016	5,123	2,255	4,296	3,181
Wagons and trucks, complete	35,157	23,973	26,317	4,406	3,093	3,701
Parts of railway vehicles:						
Axles, tyres and wheels	84,051	81,217	141,512	6,391	6,204	9,256
Other n.e.s.:						
For railway carriages	1,849	4,096	5,893	1,056	1,902	2,447
For wagons and trucks	11,368	43,609	46,203	1,592	5,038	5,107
Others	16,658	16,894	18,172	6,110	6,708	6,507
	195,751	210,357	267,180	40,447	45,313	43,112

(*a*) Partly estimated.



(1) Estimated on first nine months
(2) Estimated on first six months

United Kingdom production of steam locomotives, Diesel locomotives, coaching vehicles and wagons, from 1953 to 1957.

Continuing Management

numbers on order should bring the total number in use by the end of 1958 up to about 1,100.

Expenditure on the British Railways modernisation plan has been steadily rising. The estimated capital expenditure in 1957 was about £120 million, compared with about £90 million in 1956. The emphasis is now to some extent shifting from installations towards traction, as the locomotive building programme gathers way. In the home market, therefore, the British locomotive builders should be in a moderately comfortable position during 1958.

The year 1957 has, however, not been particularly satisfactory. Somewhat surprisingly in this period of transition, the estimated number of steam locomotives produced in 1957 has risen compared with 1956. At the same time, however, the total output of Diesel and Diesel-electric locomotives has dropped from 937 to an estimated 882. These official figures may, however, be slightly misleading in that they are based on Board of Trade figures for the first half of 1957. They thus take no account of the estimated deliveries of Diesel main-line locomotives in the second half-year, which may raise the total output by 10 or 20 units. It is clear, however, in any case that the total production of Diesel and Diesel-electric locomotives is not expanding at a great rate and may in fact have slightly declined during the past year.

Some concern was expressed towards the end of 1956 in that the volume of new locomotive orders coming from abroad was not equal to the current rate of export and that there might be some shortage of export work during 1957. This appears to have taken place in that the total number of Diesel and Diesel-electric locomotives exported in 1957 is estimated at 468, compared with 537 for 1956. As would be expected, the exports of steam locomotives have remained at the low level of 1956 following the large drop from 1955, and it is doubtful whether any change can be forecast in this field. What has not taken place, however, is a corresponding increase in exports of Diesel and Diesel-electric locomotives. The figures in Table III show the extent of this fall in money terms. Exports of steam locomotives fell slightly from just over £4 million to £3·8 million in 1957, while exports of all other complete locomotives dropped considerably from £13 million to just short of £9 million. This latter fall was largely caused by a very considerable drop in exports of Diesel-electric locomotives; for the first nine months of 1957 exports of this category were valued at £2,600,000, compared with £6,800,000 for the corresponding period of 1956.

Considering locomotives as a whole, exports to all foreign countries dropped without exception and the same applies to most Commonwealth countries. Exceptions were Ghana and the Union of South Africa, where exports increased considerably. In general, therefore, it has been true during 1957 that the locomotive builders have had a somewhat difficult time.

The outlook for 1958 is distinctly more hopeful. Although total capital expenditure by British Railways is to be kept at a lower level in real terms than was originally envisaged, the shift of emphasis is taking place towards traction, and increasing numbers of locomotives will be delivered during the coming year. At the same time several encouraging and large orders have been booked overseas, in particular for electric locomotives. During the year, South African Railways have placed the largest single order for electric locomotives in their history, exclusively in the United Kingdom. The total number of locomotives involved is 190, of which 135 have been ordered from Metropolitan-Vickers and 55 from English Electric; the total value of these orders approaches £11 million and the locomotives should be delivered over the next two years.

Output of railway carriages and wagons continues at a high level and it seems likely that this level will be maintained or increased during 1958. Though exports of railway carriages declined slightly during 1957, those of wagons increased by a corresponding amount and the general level was more or less maintained. Overall, in spite of a decline in locomotive exports, the total exports of railway vehicles declined only slightly owing to increased exports of locomotive parts and wagons. In the meantime, during 1957 encouraging export orders have been received for railway carriages and wagons and there should be an overall increase in exports during 1958.

Warning notes have been sounded by some of the British wagon manufacturers as to the effect of rising production costs on exports in competitive markets. In this connection it is notable that British manufacturers are not alone in experiencing price competition; in March, 1957, it was stated that the German locomotive manufacturers had suffered severe losses from foreign competition and their exports have declined by 40 per cent. between 1954 and 1956. This was mainly attributed to competition from Japan and the Soviet bloc, which has also been experienced by some British manufacturers; as reported in this series last year, in some cases both British and German manufacturers have quoted the lowest possible tender and have still been undercut by many thousands of pounds by Japanese producers.

During 1956, raw material supplies were stated to be still unsatisfactory and to be a definite brake on increasing production. During 1957 this situation has improved somewhat, but supplies have still been stated to be inadequate.

In general, therefore, the outlook for the locomotive and rolling stock industry in 1958 is encouraging. Both on the home market and in the export field there should be a steady improvement in the position through the next year, though it is unlikely to be spectacular.

What the Future Holds for

MACHINE TOOLS

The machine tool industry finished 1957 with a lower order book than at any time since the figures were first collected in 1952. By the end of the third quarter of 1957, total orders on hand amounted to £85·23 million. The average monthly delivery rate for the first nine months of 1957 was £7·92 million, so that orders in hand at the end of September represented on the average rather under 11 months work, as compared with over 12 months work in January, 1957. Overall, therefore, the decline in orders in hand, first apparent in July, 1956, has continued during 1957. The decline in new orders in fact goes back further, to the early part of 1956, but it was not until July that the rate of output caught up with new orders. The process has, however, been much accelerated in 1957 and in general, orders have been running at about 20 per cent. below deliveries.

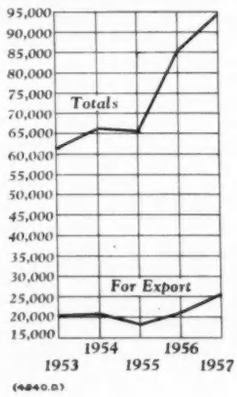
The process has not been continuous however. There was quite a marked recovery in orders for the home market during the first quarter of 1957 when they totalled £14·94 million compared with £14·4 million and £13·7 million for the third and fourth quarters of 1956. The recovery led to some hopes in the early part of the year that the setbacks which the industry had encountered in the home market were being surmounted. At that time, it was noted that the recession in the vehicle industry, the machine tool makers' best customers, had not made such a severe impact as had been feared, the major companies having in general pursued their long term programmes with only minor alterations. The general level of inquiries from the engineering industries was then higher than had been expected. Export orders for the first quarter reached the very high level of £7·18 million.

This state of affairs did not, however, persist, and even in the first quarter, deliveries were being stepped up sufficiently to exceed the increased rate of orders. In the second and third quarters orders have continued to decline, and overseas orders received in September were only £1·12 million, or half the level reached only five months previously. Home orders have similarly dropped.

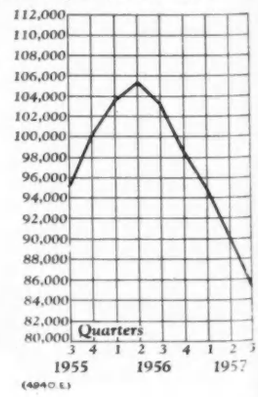
The overall position can perhaps best be seen by comparing the orders received during the first nine months of 1957 with the corresponding period for the previous two years. For the years 1955 to 1957 these figures were respectively £74·96 million, £50·08 million, and £42·83 million. For exports, the figures are less disturbing, being respectively £21·04 million, £16·96 million, and £17·15 million.

There is material in these figures to confound the persistent critics of the machine tool industry. For at least two years, the industry has been blamed for allowing order books to extend to a point at which new orders, particularly in export fields, were being lost owing to prolonged delivery periods; at which imports were being encouraged since British buyers could obtain better delivery dates overseas, and for the general conservatism which this state of affairs implied. During 1956, the average delivery period reached the figure of 16 months in July, which implied in some categories of heavy machine tools deliveries as long as 20 months. By January, 1957, production had expanded appreciably and, combined with declining orders, the average delivery period was only just over 12 months. There may perhaps have been some grounds for believing that the recovery in orders in the first quarter was the result of this shortening of delivery periods. However, the results for the remainder of 1957 certainly do not justify this view, since with steadily improved deliveries, orders have persistently declined.

So far the figures have been on the debit side. On the credit side it must be recorded that output by the machine tool industry has improved considerably during 1957, both for home and export markets. Possibly partly as a consequence of increased production and reduced delivery dates, imports have been reduced so that for the first three quarters of 1957 the



United Kingdom deliveries of machine tools in £1 thousands, totals and exports (1957 figures partly estimated).



Value of machine tool orders in hand in £1 thousands.

TABLE IV *United Kingdom Exports of Metal-Working Machine Tools, 1955 to 1957*

	Quantities (1,000 cwt.)			Value (£1,000)		
	1955	1956	1957 (*a*)	1955	1956	1957 (*a*)
Union of South Africa	61	51	61	1,469	1,301	1,575
India	106	107	128	2,407	2,657	3,522
Australia	135	131	151	3,703	3,781	4,174
New Zealand	24	14	15	608	398	396
Canada	50	83	71	1,234	2,160	2,089
Other Commonwealth countries	71	68	62	1,716	1,739	1,609
Soviet Union	41	55	55	619	830	1,056
Sweden	22	34	23	703	1,014	855
Western Germany	27	19	27	420	634	1,257
Netherlands	35	34	32	592	791	802
France	46	55	58	1,541	1,867	2,175
Belgium	16	16	18	493	429	481
Spain	22	28	48	648	992	1,504
Italy	35	12	30	836	516	949
United States of America	32	59	92	936	1,554	2,828
Other foreign countries	105	114	97	2,900	3,169	3,259
Totals	828	880	968	20,825	23,832	28,531

(*a*) Nine months annual rate.

United Kingdom was a net exporter of machine tools. Rising prices to some extent obscure the actual scale of this increase in output but in money terms output has risen from £62 million in 1953 to nearly £95 million in 1957.

The largest customers for United Kingdom machine tools remain in the Commonwealth. The Suez Crisis appears to have had relatively little effect on exports to Australia in the last quarter of 1956, and the first nine months of 1957 show an increase over the corresponding period for 1956. Exports to India, which increased slightly between 1955 and 1956, rose by 33 per cent. in 1957 and are now approaching the value of exports to Australia. Here again, remarkably little evidence is shown by the figures of any dislocation due to the Suez Crisis. A further encouraging feature of the Trade figures is that imports from the United States for the first nine months of 1957 declined by 23 per cent. compared with the same period for 1956, while exports for the same period rose by over £1 million or 115 per cent. Exports to Canada also increased.

In Europe exports to all countries except Sweden and Denmark rose by an appreciable margin. France, already a large customer in 1956, took 26 per cent. more in the first nine months of 1957 than in the same period in 1956, while exports to Western Germany doubled. In the latter case, however, it must also be borne in mind that imports from Western Germany rose by very nearly the same amount in value and remain at a high level, estimated at £8·2 million per annum. The decline in exports to Italy, which was very marked in 1956, has been reversed and the figure for 1957 exceeds that for 1955. Taking Europe as a whole, excluding Switzerland, there is still a very appreciable balance of imports over exports amounting to an estimated £3·2 million for a full year. While exports to Europe are fairly well spread over all countries, over 80 per cent. of imports from the continent originate from Germany. This excludes Switzerland whose special position more or less assures that she will continue to show a large excess of exports over imports. The balance of trade between the United Kingdom and other countries thus consists very largely of net imports from Europe, a large balance of imports from the United States, and a corresponding flow of exports to Commonwealth countries. Imports from Germany and the United States consist largely, though by no means entirely, of types of machine tool not made in this country.

Several factors contribute to this situation. In the first place it is clear that the level of imports is not to any appreciable extent governed only by delivery dates of British manufacturers. It is, of course, dangerous to generalise in that there will almost certainly continue to be a whole range of machine tools which other countries can manufacture better than British manufacturers. This, of course, particularly applies to Switzerland, but it may well be questioned whether quality has not something to do with it.

It is perhaps significant, though a little early for serious comment, that from figures so far published, export orders have shown little beneficial results from the European Machine Tool Exhibition held in Hanover in the latter part of September. It may well be, however, that some large orders resulting from this exhibition will appear in later figures. Most of the 44 British exhibitors (out of a total of about 1,000 from all countries) were reported to be pleased with the results achieved, and were hopeful of contracts in the near future. An encouraging German opinion was quoted at the time of the Exhibition that British manufacturers had over the past few years made considerable technical advances, and in one field at least—that of accurate positioning—were now second to none. The advances in electronic control were reflected in the large volume of inquiries received by E.M.I. Electronics concerning their punched-tape systems.

It is notable that the German manufacturers are maintaining an export ratio of around 40 per cent. on average, though in the case of some specialised manufacturers of, for example, transfer machines, this figure is over 60 per cent.

It may well be that potential foreign buyers held off during the months preceding the Hanover exhibition and that a recovery will be shown when subsequent order figures become available.

However, if this declining trend of export orders continues, the machine tool industry will not enter the era of liberalisation of trade in Europe in a very satisfactory position. In the second place there is still a very large reliance on supplies of machine tools from the United States, though, as mentioned above, this is being reduced.

Hitherto, competition from Russia in the machine tool field has not been extensive. However, a German team of experts touring Russia during 1957 foresaw increased competition from this source. Russian competition is unpredictable in any field. The organisation of the Russian economy makes it possible at any time that a large surplus or shortfall of production may occur. In either case a large and sudden volume of trade may result without warning and which may not be symptomatic of future trends. This has been a feature of trade between the Soviet bloc and the free world for some years, and it is perhaps to be expected that for political reasons, surplus production should be offered in the export market at very low prices or on exceptionally favourable credit terms. It may not, therefore, be of great significance for the future that in some recent cases both German and British manufacturers have been heavily outbid by East German manufacturers.

In the case of machine tools, serious competition from Russia may not materialise in the immediate future, but is worth some consideration in taking a long-term view. The Russian economy has been forced over the past few decades to concentrate on heavy industry and the production of capital equipment. At some point the emphasis must shift to consumer goods, with a decline in Russian home demand for capital goods. At this point the Russians may in all probability possess a larger and more efficient industry for machine tool manufacture than any in the West and, with central control, could if they wished, dispose of large quantities of capital goods in the underdeveloped areas at dumping prices. While present competition with Russia may arise in many cases from Russian miscalculation, this is small comfort for those who are outbid, though at present such competition is on a comparatively small scale. In a few years time it may become more serious.

Perhaps the most serious feature of the present situation for the machine tool industry is the trend in investment in this country. The decline in home orders for new machine tools must lead to a serious fall in deliveries towards the end of 1958 and during 1959. The present situation is, of course, very largely a result of altogether impossible demands having been made on the capital equipment industries during the investment boom of 1954 and 1955. It may well be argued that the machine tool industry was wise in not yielding to pressure to expand their output at a much greater rate. It is, in any case, doubtful whether in view of material and labour shortages, they could have done so.

The effect of the official measures since taken, which were devised to meet a very real crisis, has fallen much more heavily on investment than on consumer spending. The question now is very much less one of whether the machine tool industry is doing all it can to supply the capital equipment needs of British industry, than whether the level of capital investment now proceeding in the United Kingdom is sufficient to meet the increased competition which will certainly develop as the Free Trade Area comes into operation. The solution is not, of course, in the hands of the machine tool manufacturers at all.

It certainly appears that if present policies are not modified, the machine tool industry as a whole is facing a lean period. The date at which production begins to fall off will vary for different sections of the industry, but while manufacturers of some classes of machine tools may be able to maintain the level of production for the greater part of the coming year, others must be affected very much earlier. It is certainly to be hoped that the Government will find itself in a position to provide some stimulus to investment before the machine tool industry is forced to dispense with the skilled labour force which it has laboriously built up over the last few years.

What the Future Holds for

TEXTILE MACHINERY

For British manufacturers of textile machinery, 1957 was a year of mixed fortunes. While output and exports of certain types of machinery continued to expand, over a wide field of the industry production remained virtually static, while exports declined. In the home market, producers of hosiery and other knitting machinery have done well consequent upon the expansion in demand from that side of the textile industry. In 1957, production of hosiery and knitting machinery expanded by approximately 9 per cent. and totalled roughly £1·1 million. Nearly three-quarters of this total was sent abroad. The success experienced by manufacturers of hosiery and knitting machinery, however, has not been shared to any extent by manufacturers of other types of machinery as can be seen in the diagram on page 54, and in Table V.

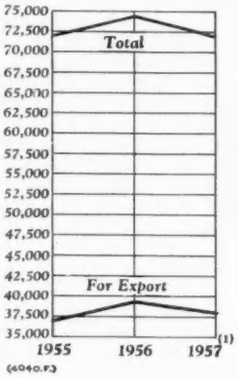
The textile machinery industry is heavily dependent on the export market and its export ratio is well over 50 per cent. of total production. In 1957, however, there was a marked drop in exports of most types which reflected growing foreign competition. The Commonwealth, particularly that part which lies east of Suez, continues to be the most important outlet for British manufacturers of textile machinery, although last year there was a notable drop in exports to the leading customer, India, from £10 million in 1956 to £7·5 million in 1957.

British exporters of textile machinery were not the only ones who experienced difficulties in the export market last year. Japanese manufacturers, despite their competitive prices, experienced a heavy fall in demand from both home and export markets in 1957. Indeed, the Japanese textile machinery industry has appealed to the Government to work out some system to help expand its lagging export sales. In particular, the Japanese manufacturers received

Continuing Management

a sharp setback in trade with Pakistan. From 1950 to 1955 Pakistan was Japan's best customer, taking from 30 to 50 per cent. of the Japanese industry's total exports of textile equipment. Japan's current exports to Pakistan have dropped to about 1 per cent. of her total sales aborad. One reason is that the Japanese manufacturers have found themselves unable to compete with the credit terms offered by their competitors.

Japan has also been experiencing competition from behind the Iron Curtain. Many Indian mills have installed cheap Chinese machinery, and increasing competition from Eastern Germany is reported throughout South-East Asia.



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United Kingdom deliveries of textile machinery, years ending June, 1955 to 1957 (£1,000).

(1) Partially estimated

West German manufacturers have also become very active in this area. Bremen Spinnbau G.m.b.H. for example, are said to be sending the bulk of their exports to East and South-East Asia. Towards the end of last year this company announced the construction, in conjunction with another West German firm, of a model spinning works with 10,000 spindles in South Korea.

From this brief review of other countries' activities in countries which were formerly the principal markets for United Kingdom manufacturers, it is apparent that the latter will have to fight hard to keep their place in the Far East. Meanwhile they have had rather better success nearer home. It is encouraging to note, for example, that while competition from the Soviet sphere may affect out sales to traditional markets, some United Kingdom manufacturers have, so to speak, been carrying the war into the enemy's camp. Orders amounting to nearly £2 million have been placed by the Polish Government with companies in this country. Platt Brothers Limited have secured orders for cotton and worsted machinery to the value of about £1 million from the Polish Government for the equipment of two mills, while James Mackie and Sons, Limited, of Belfast, have won the major part of an £850,000 order from the same source. This represented the first major sale to the Polish market since the war.

Meanwhile, the visit of the Chinese economic and technical delegation to this country last year resulted in some orders for textile machinery from that country, although the exact extent of these orders is not yet known. Trade with the Soviet bloc, however, tends to fluctuate from year to year.

In view of their dependence on the export market, the proposed European Common Market and Free Trade Area is being studied by textile machinery manufacturers with close interest. Last year 22 per cent. of the industry's total exports went to Western Europe and in general sales to this area have been mounting fairly steadily over the past few years. Sales to France and Italy showed a marked increase in 1957, while exports to Western Germany have been maintained despite the growing output of German manufacturers. In view of their high reputation for quality on the Continent, British manufacturers of textile machinery stand to gain a good deal from expanding markets in Western Europe, when the liberalisation proposals start coming into effect in January, 1959, provided of course, that the Free Trade Area proposals come into force at the same time. They should, however, note that Swiss manufacturers also have an excellent name for quality and their machines are in popular demand in the more advanced European countries.

TABLE V *United Kingdom: Exports of Textile Machinery by Main Machinery Groups*

	Quantities (1,000 cwt.)			Value (£1,000)		
	1955	1956	1957(*a*)	1955	1956	1957(*a*)
New:						
For making synthetic fibres	21	21	23	751	946	862
For spinning and twisting and preparatory processes	991	882	710	23,525	22,241	19,018
For processes preparatory to weaving but subsequent to spinning and twisting	59	54	58	1,838	1,710	2,027
Looms and other weaving machinery	257	269	234	4,610	5,074	4,434
Bleaching, dyeing, printing and other finishing	102	118	88	2,671	3,214	2,658
Hosiery and other knitting	54	56	67	5,371	5,989	7,493
All other textile machinery	55	67	62	1,906	2,444	2,341
Accessories separately consigned:						
Bobbins	7	7	7	264	291	284
Card clothing	20	25	24	1,062	1,407	1,486
Shuttles	6	5	4	261	233	190
Other	21	25	20	457	599	569
Second-hand	59	81	89	582	847	827
Total	1,652	1,610	1,386	43,298	44,995	42,189
Of which to:						
Union of South Africa	42	25	41	1,053	848	1,147
India	307	404	286	7,295	9,861	7,468
Pakistan	225	73	94	4,298	1,489	2,236
Australia	65	46	74	1,981	1,546	2,740
Other Commonwealth countries	72	85	89	2,137	2,512	2,764
Irish Republic	30	35	37	613	736	675
Soviet Union	193	82	43	4,448	2,100	1,520
West Germany	55	56	56	2,130	2,263	2,251
Netherlands	42	42	41	1,020	1,131	1,232
Belgium	45	49	43	1,231	1,323	1,348
France	64	65	83	2,119	2,495	3,127
Portugal	25	37	31	591	801	779
Italy	28	31	47	1,085	1,419	1,557
Other West European countries	46	31	31	1,530	1,335	1,438
Japan	8	10	24	266	479	909
Philippines	14	33	34	333	757	907
United States of America	54	59	49	1,932	2,315	2,166
Mexico	47	67	63	1,053	1,691	1,569
Other foreign countries	291	379	210	8,181	9,893	6,311

(*a*) Nine months annual rate.

Sales to North America have, of course, been affected by the minor recession in the United States. Nevertheless, a reduction in demand from the United States and Canada has in part been offset by expanding sales to a relatively new Dollar Area customer, the Phillipines. Platt Brothers had by July, 1957, received orders from this source exceeding those of the preceding year by 3 million dols. Export demand from South America is erratic, mainly due to the complex exchange restrictions in force. As regards prospects for 1958, the United States recession is expected to continue at least through the first half of the year and British exports to the United States may decline further as a result. The recent visit of the Canadian Trade Mission, however, may result in increased exports to Canada to offset any decline in orders from the United States.

In view of the greatly increased activity in synthetic fibres over the last few years it is somewhat surprising to note that exports of machinery for their manufacture declined in value in 1957. This emphasises the importance of technological research if the United Kingdom textile machinery industry is to take full advantage of new developments in this field.

Two important technical developments were announced in this country last year. The British Cotton Industries' Research Association continues to pioneer technological developments in the cotton industry and arrangements were last year completed to undertake large-scale commercial production of the Shirley pressure point system in card dust extraction. The Shirley Institute, however, is limited by financial factors and while it does useful work in pioneering new developments in textile technology, major technological development must be the responsibility of the large companies in the textile machinery industry. Fairbairn Lawson Combe Barbour Limited, for example, have now concluded their tests on their new Magnaspin spinning machine for worsted and synthetics and expect to get good orders as a result. A new automatic hank-dyeing machine, said to be the world's largest, has been put into operation by the Birstall Carpet Company, Limited. The machine, developed by the Longclose Engineering Company, Limited, a subsidiary of Platt Brothers, is said to have a high rate of mixing and a high distributing efficiency; it has a liquor capacity of 12,500 gallons.

Most major technological developments over the past year, however, have been announced in other countries. Last year's Outlook article commented on the fact that the Czech and Swiss shuttleless looms were gaining in popularity both here and in other countries. The Czech shuttleless loom was introduced as far back as 1955, but as yet there is no British model on the market. A shuttle-free loom in which an air jet blows the weft thread through the shed was launched last year on the Swedish market. This loom, which was developed by A.B. Maxbo of Norrköping, combines simplicity in design with a very high pick speed.

What the Future Holds for

COAL AND ELECTRICITY

Coal last year provided a prime example of the way in which the best laid schemes of improvement can founder on labour troubles. For several years past, coal output has remained approximately static and in face of the rapidly rising energy requirements of the United Kingdom it was widely believed—with considerable foundation—that coal output could not effectively be raised above its present level and that oil and atomic energy would have to meet these needs.

In the early part of 1957 two factors appeared to be about to upset this theory. The oil supply difficulties of that time cast serious doubts on the wisdom of relying too heavily on oil imports, while it appeared that for the first time the expenditure by the N.C.B. on modernisation and the growing introduction of mechanised coal

getting and loading was at last yielding results. Indeed, during the first five months of 1957, output of coal from all United Kingdom sources exceeded the output for the same period in 1956 by about 3 million tons. Over a full year it could therefore reasonably have been hoped that 1957 output could have exceeded that of 1956 by upwards of 6 million tons.

In view of this startling increase, representations were in fact made by the N.C.B. that the contracts entered into by the Central Electricity Authority for the future supply of fuel oil for power stations should be revoked. This in the event proved premature. During the early part of 1957, increasing pressure had been brought to bear by the miners for the consolidation of the "bonus shift" with the standard weekly wage. There were some misgivings about this, and in fact it was estimated that the rise in absenteeism which might result could cost the N.C.B. as much as 4 million tons of coal a year. This has proved to be no over-estimate. In spite of an assurance from the miners that absenteeism would not rise, it did do so.

The result has been that in spite of increasing output per man shift, production each week has lagged behind the corresponding week of 1956, and it is unlikely that 1957 production will exceed that of 1956 by more than 1½ million tons. Moreover, most of this gain will have been made on open-cast operations. The coal supply position is thus much as it was. While it is clear that increasing mechanisation and rationalisation of pits provide the only means of raising coal output, these means cannot be fully utilised without surmounting management problems, which appear to become more intractable with the passing of time.

The increased power-loading facilities introduced in 1956, with disappointing results in that year, clearly showed results in the first half of 1957. This by itself is not, of course, the only answer. It was found in some cases that increased mechanisation at the coal face itself only led to severe bottlenecks further back up the pit, and it is probable that coal-face mechanisation will set off a chain reaction leading to the introduction of more and better haulage and winding equipment. In addition, increased mechanisation leads to a higher proportion of dirt in the coal got by these means, so that improved coal-preparation plant is required.

These needs have not yet been reflected to any great extent in output in these categories, but it may be expected that within the next year production of this type of machinery will increase. Output of power loaders has risen steadily. During the first half of 1957, there were over 1,000 power-loading machines in operation in British mines, implying that about 20 per cent. of all coal faces being operated were on a fully mechanised basis. The average output per man shift on mechanised faces has been raised to 5·83 tons from 3·56 tons for conventional faces. Production of the Anderton shearer, which is now the most widely used power loader, has risen steadily. By the end of 1956 215 were in operation and it was hoped by the end of 1957 that 450 would be in use. The introduction of this machine has led to certain complications regarding coal supplies. The machine inherently produces more small coal than conventional methods and, in spite of intensive sales efforts, householders will not on the average take small coal. There is, therefore, likely to be an increasing trend towards the introduction of new types of power loaders capable of producing more large coal. This principally involves two new types of machine—the Huwood "Slicer" and the Anderson-Boyes "Trepanner." At the end of March, 1957, there were only 19 Trepanners and 11 Slicers in use in the pits, but the numbers installed are rising rapidly and will continue to do so.

Exports in the mining machinery industry play a comparatively small part and have during 1957 on the average declined slightly from the figure achieved for 1956.

As is the case with other capital industries, the heavy electrical industry suffers from considerable uncertainty as to future Government policy. In the first instance an expenditure of £230 million on capital equipment was approved by the C.E.A. for the year 1956/57. This was subsequently reduced to an estimated £195 million by postponing new construction, but finally an expenditure of £206 million was approved for that year. As was forecast in this series last year, the atomic power programme was considerably expanded early in 1957, and corresponding to this the estimated capital expenditure of the Central Electricity Authority for the year 1957/58 was raised to £233 million, this rise being mainly accounted for by the nuclear programme.

Under the revised nuclear power programme announced at the beginning of 1957, it was hoped that 6,000 MW of nuclear power would be brought into operation by the end of 1965. A full year's operation with this generating capacity would save some 18 million tons of coal. The cost of the nuclear power stations was estimated to be about £1,460 million, and 16 more stations would need to be constructed in addition to the three for which orders had already been placed.

This programme has again been modified, and at the end of October, 1957, the Central Electricity Authority announced that the investment on nuclear power stations will be cut by some 10 per cent., or £90 million, during the period ending December 31, 1965. Although the decision was taken to keep the investment in nuclear power within the limits so defined, no decision had at that time been reached as to how the nuclear power programme would be worked out in detail. It was suggested at that time that since the cuts were monetary rather than in capacity terms, it could well be that technical developments would lead to the construction of some ten nuclear power stations, costing between £750 million and £800 million, with a total generating capacity of more than 5,000 MW.

According to a statement by the Paymaster General, the four nuclear power stations already ordered will proceed as planned, but there will be some delay in the starting of later stations in the programme. The net effect of the latest investment cut is that the target originally set will be met one year later than announced.

In spite of the curtailment of expansion in the home market, output of all classes of electrical generating plant and machinery, with the exception of the larger steam turbo-alternators, rose by a reasonable margin in 1957. The increase was not, however, so great as that recorded between 1955 and 1956. Exports of the same categories also rose steadily. Considerable success has been achieved during 1957 in winning large export orders for heavy electrical plant against keen foreign competition, and in some cases total order books have lengthened considerably in 1957. One outstanding order for generating plant has been obtained from the Argentine. The estimated value of this contract is over £30 million, which is roughly half the current annual level of exports of electrical generating plant and machinery for the whole of the U.K.

The heavy electrical industry will, of course, be affected both by the revision of the nuclear power programme and by any cutback of plans for new steam power stations that may be announced later. As plans stand at present, 118 steam generating sets with a total capacity of 10,000 MW are to be constructed by 1962. Deliveries to the home market are likely in 1958 to remain at about their 1957 level or slightly higher, but in view of the large overseas orders obtained during 1957, export orders may well be stepped up. Overall, therefore, there should be a steady increase in output of electrical generating plant and machinery in 1958. A further factor affecting this is that large additions to capacity have been completed by the major manufacturers during 1957, and the full effect of this new machinery should begin to be felt during 1958.

Output of shell boilers is estimated from the figures so far available to have risen by about 8 per cent. during 1957, and exports have increased slightly. As would be expected, in view of the oil supply difficulties in the early part of the year, output of fuel oil burners declined appreciably from the high level reached in 1956. The figures for deliveries of steam-raising plant do not, of course, cover the full range of boilers and boiler house plant, though figures are available for exports over the whole range. These show a fall in 1957 compared with 1956 of about 11 per cent., from about £17·5 million to £15·6 million. Exports to Commonwealth countries were practically unchanged and the decline was mainly accounted for by exports to foreign countries.

TABLE VI *United Kingdom Deliveries of Coal-Mining Machinery, Electrical Plant and Machinery and Steam-Raising Plant*

—	Unit	Total					For Export				
		1953	1954	1955	1956	1957(*a*)	1953	1954	1955	1956	1957(*a*)
Coal-Mining Machinery											
Coal cutters	Number	968	991	931	715	646	215	108	89	91	120
Power loaders (*b*)	,,	63	99	104	377	412	3	4	5	44	26
Underground conveyors	,,	3,846	3,980	3,766	2,960	n.a.	611	293	320	285	n.a.
Diesel underground locomotives	,,	103	122	106	89	92	24	22	10	26	22
Coal preparation plant	£1,000	8,832	9,797	11,169	11,509	10,232	1,367	386	219	658	376
Winding and hauling equipment	,,	4,844	5,727	6,909	6,112	6,222	1,124	766	731	696	898
Tubs and mine cars	1,000 tons (*c*)	64·7	75·6	70·7	54·9	54·2	—	—	—	—	—
Electrical Generating Plant and Machinery											
Hydraulic turbines	Thousand B.H.P.	736·8	507·6	446·4	165·6	840·1(*e*)	682·8	404·4	303·6	114·0	696·4(*e*)
Steam turbo-alternators (10 MW and over)	MW	2,516·4	2,342·4	2,619·6	3,372·0	2,551·4(*e*)	891·6	772·8	828·0	834·0	765·0(*e*)
Steam turbines (less than 10 MW)	,,	190·8	214·8	192·0	170·4	211·2(*f*)	73·2	98·4	78·0	48·0	67·2(*f*)
Rotary electrical machines, 1–250 h.p., kVA or kW	£1,000	29,352	27,240	31,572	36,048	38,862(*g*)	5,256	5,316	6,072	6,852	7,254(*g*)
Over 250 h.p., kVA or kW	,,	5,928	7,404	8,580	9,864	11,433(*g*)	2,532	2,652	2,412	2,712	3,499(*g*)
Steam-Raising Plant											
Shell boilers	£1,000	9,744	9,984	10,320	10,056	10,789(*g*)	1,932	2,292	2,052	1,896	2,036(*g*)
Steam-raising plant accessories:											
Fuel oil burners	,,	3,084	3,432	4,956	6,624	5,541(*g*)	516	672	732	852	850(*g*)
Other (*d*)	,,	9,708	9,756	11,292	11,328	12,096(*e*)	1,812	1,596	1,464	1,860	1,947(*e*)

(*a*) Partly estimated. (*b*) Including cutter-loaders. (*c*) Carrying capacity. (*d*) Excluding marine types. (*e*) Estimated on first nine months. (*f*) Estimated on first six mon
(*g*) Estimated on first eight months.

Book Reviews

CAUSES OF BRITTLENESS IN STEEL STRUCTURES

Brittle Behaviour of Engineering Structures. By EARL R. PARKER. Prepared for the Ship Structure Committee under the general direction of the Committee on Ship Steel National Academy of Sciences—National Research Council. *John Wiley and Sons Incorporated*, 440 *Fourth-avenue*, *New York* 16, *N.Y.* (3.50 dols.); and *Chapman and Hall Limited*, 37 *Essex-street*, *London*, *W.C.*2. (28*s.*)

The earliest recorded discussions on brittleness and crystallinity in iron and steel structures date almost from the inception of the older metallurgical and engineering institutions in the world. For instance, the names of McConnell, Robert Stephenson and John Roebling were all linked with the subject in the 1850's. David Kirkaldy, in 1862, devoted a substantial part of his book on *Experiments on Wrought Iron and Steel* to minute descriptions of cleavage and shear in broken test pieces. When this early and remarkable awareness is considered it is surprising that, one hundred years later, there should be so few authoritative text books to which the constructional engineer may turn for concise guidance on the avoidance of brittle fractures.

The Ship Structure Committee book now under review, together with its contemporary *Control of Steel Construction to Avoid Brittle Failure* from the Welding Research Council, has been produced to summarise available information for the benefit of practising engineers and metallurgists. The Ship Structure Committee was created after the spate of brittle fractures in welded American merchant ships, produced for the second world war. Many of its extensive researches have been conducted through the National Academy of Sciences—National Research Council, and the present work is the outcome of a committee activity, with Professor Parker as author. The members of this team, mainly composed of metallurgists, have contributed significantly to recent researches.

The scope of the book on notch effects and transition temperature tests, steel composition, welding, residual stresses, design and workmanship, and the consideration of casualties is set out at length in an introductory chapter. Each succeeding chapter is reinforced with a summary, and the approach throughout is such as to call for little specialised knowledge on the part of the reader.

In the two chapters on concepts and theory of fracture, the treatment is developed in terms of shear and cleavage fracture, mainly from Ludwik's ideas of separate deformation resistance and fracture strength. While far from outmoded, such theories have been usefully supplemented in recent years by studies of the basic processes of slip, cleavage and twinning, and their interdependence in single crystals. A better balance would have been achieved if some of the latter had been substituted for the exhaustive discussion of polycrystalline ductile fracture—largely irrelevant in the context of brittle fracture.

Considerable space is devoted to transition temperature testing methods and to the interpretation of the results obtained by the application of tests to a variety of steels. Tests on both unwelded and welded materials are first distinguished as to size, shape and type of loading. In view of the large number which have been evolved, any classification might have been stultified, but it is interesting to see the conclusion that shape effects at notches are obscured at the stage after which natural cracks are formed, so that fracture appearance transition temperatures are little dependent on testing conditions. This is in full agreement with the findings of Dr. Tipper in Britain with regard to the notch tensile test. In spite of the attractiveness of the fracture appearance transition temperature from the scientific viewpoint, much of the book's discussion is preoccupied with the ductility transition, which is the temperature below which brittle fracture occurs with substantially no prior plastic deformation. This may be regarded as inevitable in American work since the classic Bureau of Standards investigation on correlation between ship casualties and small-scale tests was carried out almost exclusively with measurements of energy absorption in the Charpy V-notch test. It is widely recognised that fracture appearance transition temperatures for most semi-killed structural steels are significantly higher than those at which casualties occur. In contrast, however, this is not so with some higher strength and low transition temperature steels now coming into use, and in such cases the 15 ft. lb. energy absorption for the ductility transition with which the book is much concerned, is lacking in conservation. Many isolated test results are quoted in these chapters for these steels but this feature is not given sufficient prominence.

Although transition temperature tests have not been entirely successful in predicting the behaviour of steels in large structures it is also true that steels with increased notch toughness could not have been identified and developed without their use. In this respect the importance of chemical composition and manufacturing practice have been amply demonstrated, and a chapter concerned with the empirical approach is incorporated in the book.

A long history of brittle fracture casualties existed before the welding era, but there are several reasons why welded structures should receive special consideration; the free passage for running cracks through a monolithic structure and the tendency towards the use of larger thicknesses of material with less notch toughness may be specially mentioned. The first revelations of fractures in welded structures, such as the Hasselt Bridge and Liberty ships, induced a wide belief in the importance of residual stresses, with a tendency to ignore earlier failures in riveted structures. A reversal of views followed the wide recognition of temperature transition behaviour. One current view is that residual stresses do not, of themselves, influence transition temperatures but that the strength of structures operating in the brittle condition may be significantly reduced if the residual stresses supplement those externally applied. The existence of the controversy may have influenced the author to devote separate chapters to the role of welding and residual stresses, with the former primarily concerned with estimates of notch toughness in weld metal and heat-affected zones. From the diversity of experiments and casualties discussed in the second chapter with reference to residual stresses it is concluded that (page 231): " laboratory test results and theoretical analyses indicate that such stresses are of minor importance to the life of large structures. However, operating field engineers are familiar with an uncomfortable large number of failures that are apparently unexplainable on any other basis." Perhaps a closer approach to the truth might have been cited, if the European literature had been consulted.

The final part of the book, on the design, workmanship, and casualties in land-based structures and ships, draws deeply from the historical survey made by Professor Shank and the work of the Ship Structure Committee itself. It is forthright and clear in distinguishing good and bad practices and the breadth of experience represented ensures an authoritative view.

In general terms, however, the book is disappointing, both for omissions and a certain lack of deftness in drawing conclusions. A discussion on fracture morphology would have been valuable; brittle fractures have to be identified as such under conditions where fatigue, stress corrosion or some other type of failure may be suspected; information on these matters has long been available. By far the most serious criticism relates to sources for what purports to be a summary of available information. Only about 30 of the 250 references relate to work outside the United States; this has led, for instance, to discussion of longitudinal strength of ships without mention of the work of the Admiralty Ship Welding Committee on the "Ocean Vulcan," and to the consideration of fracture appearance in transition temperature tests without reference to the work of Tipper, Van der Veen, or Boyd.

The book is carefully written and well provided with illustrations and indexes. It is a good account of the work of the Ship Structure Committee over a decade but it is too narrow in scope to be considered as a textbook on brittle fracture.

ON FINDING THE RIGHT FORMULA

Mechanics. By H. WEILER. *Sir Isaac Pitman and Sons*, *Limited*, *Pitman House*, *Parker-street*, *Kingsway*, *London*, *W.C.*2. (25*s.*); and

Applied Mechanics. By R. C. STEPHENS AND J. J. WARD. *Cleaver-Hume Press*, *Limited*, 31 *Wright's-lane*, *Kensington*, *London*, *W.*8. (12*s.* 6*d.*)

The first of these books is written by a French graduate working in Australia, whence much good work is starting to come. It covers clearly the ground in statics, dynamics and hydrostatics needed for the General Certificate of Education at advanced level. While the calculus is used, no knowledge of differential equations is required, and the book could be mastered unaided.

Applied Mechanics is intended to cover the S3 year of the Ordinary National Certificate course, and includes elementary work on properties of materials, shear forces and bending moments, as well as hydrostatics. There is a large number of both worked examples and unworked examples. It is a pity that the authors include a summary of formulae, thus assisting in consolidating the belief that if only the right formula is known, a problem may be solved.

NEW BOOKS

The Rolling of Strip, Sheet and Plate. By EUSTACE C. LARKE. *Chapman and Hall Limited*, 37 *Essex-street*, *London*, *W.C.*2. (63*s.*)

Of late years many investigations on rolling and rolling problems have been conducted, and the results reported in papers presented at meetings of various learned societies. A considerable, if widely scattered, literature has grown up on many subjects concerned with rolling, as is indicated by the fact that the author of this book gives a list of 145 references. In addition to extracting and discussing the main points from the mass of published data, the author has drawn on his own long and varied experience on the subject, and shows how scientific principles have been applied to the design and operation of rolling-mill plant.

Machines for Power Farming. By ARCHIE A. STONE and HAROLD E. GULVIN. *John Wiley and Sons*, *Incorporated*, 440 *Fourth-avenue*, *New York* 16, *N.Y.* (6 dols.); *Chapman and Hall Limited*, 37 *Essex-street*, *London*, *W.C.*2. (48*s.*)

Mr. Stone is the emeritus head of the Department of Agricultural Engineering at the Long Island Agricultural and Technical Institute, while Mr. Gulvin is head of farm supply research at the Eastern Farmers' Exchange. The book has been written to help the study of farm machinery and in particular, with a view to selecting, using and maintaining typical machines. The book is designed to help teachers to develop their own special methods of imparting knowledge. Each chapter is followed by a series of questions. Although primarily written for the

American student and farmer, most of it is applicable to machines available in this country.

Fuel Saving Charts. By WALTER GOLDSTERN. Reprinted from *The Steam Engineer. John D. Troup Limited*, 90 *High Holborn, London, W.C.*1. (10*s.*)

As originally published, these fuel saving charts ran over 36 issues of *The Steam Engineer*, commencing about 18 years ago. Twenty-four were first published in one volume 5 years ago, and these have now been brought up to date and republished. They are intended to enable the operating engineer to arrive at the efficiency conditions of his plant quickly and easily, and so to keep his fuel consumption at a minimum.

Epoxy Resins: Their Applications and Technology. By HENRY LEE and KRIS NEVILLE. *McGraw-Hill Book Company, Incorporated*, 330 *West* 42*nd-street, New York* 36, *N.Y., U.S.A.* (8 dols.); and *McGraw-Hill Publishing Company, Limited*, 95 *Farringdon-street, London, E.C.*4. (64*s.*)

The two authors are, respectively, technical director and project engineer to the Epoxylite Corporation, El Monte, California, U.S.A., and their book is intended to be a comprehensive guide to the field of epoxy resins. It covers the chemistry of the preparation of the resins and their application in industry. Information is given on such subjects as the synthesis of the resins and their curing mechanisms, curing agents and the various materials employed as fillers and modifiers. To sum up, the volume is intended to provide theoretical and practical information on the new plastics and to answer questions which may occur to the users.

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Alloy Valves. LANGLEY ALLOYS LTD., Langley, Slough, Buckinghamshire. Globe, check, needle and other types of valves and strainers of the 150 lb. and 300 lb. class in stainless steel, nickel alloys, Hidurax aluminium bronze and Langalloy 20v (a nickel-chromium austenitic steel of higher nickel content than normal and containing small quantities of molybdenum, copper, silicon and manganese). Illustrated leaflets.

Combating Atmospheric Pollution. W. C. HOLMES & CO., LTD., Turnbridge, Huddersfield. The "Holmes-Catco" process is a low-temperature oxidation process by which combustible fumes, vapours, gases and odours of an organic nature are converted to odour-free gases by passage through a catalyst element before discharge to the atmosphere. Descriptive Technical Publication (No. 70).

Diaphragm Valves. WARREN, MORRISON LTD., 29 Bury-street, St. James's, London, S.W.1. Diaphragm valves designed to cater for two markets not adequately covered by the firm's pinch valves, namely: (*a*) the handling of non-corrosive liquids and gases for which the pinch valve might prove too expensive, and (*b*) the handling of really difficult applications too severe for rubber. Illustrated folder.

Aluminium-Alloy Clad Sheet. HIGH DUTY ALLOYS LTD., Slough, Buckinghamshire. Hiduminium R.R.58 in the form of clad sheet is now available for high-temperature applications. Sheets of this material may be exposed for long periods at temperatures in the range 150 deg. to 250 deg. C. For short-time exposures, the temperature can be as high as 370 deg. C. Illustrated technical brochure.

Twenty-Five Years of Aluminium-Alloy Production. INTERNATIONAL ALLOYS LTD., Haydon Hill, Aylesbury, Buckinghamshire. Production in the factory of International Alloys Ltd. on the Slough Trading Estate began in 1932. The history of the firm during the past 25 years and a description of its present activities are given in a bound album containing numerous half-tone plates.

Investment Castings. D. NAPIER & SON LTD., 211 The Vale, London, W.3. The facilities of the firm's investment-casting foundry, a self-contained organisation with its own inspection and quality-control departments, have now been made available to industry. Illustrated brochure indicating the wide range of castings available in a variety of alloy steels.

Lubricants. THE ALPHA MOLYKOTE CORPORATION, 65 Harvard-avenue, Stamford, Connecticut, U.S.A.; United Kingdom agents and distributors: AFSA LTD., 25 Victoria-street, London, S.W.1. Lubricants in paste form, and for grease-film lubrication, for dry-film lubrication and also dispersions. Illustrated catalogue.

Dust Collection. BUELL (1952) LTD., 3 St. James's-square, London, S.W.1. The Buell Microlector Van Tongeren dust-collection and fly-ash elimination system, for use in boiler installations, fertiliser works, steelworks, cement plants, foundries, collieries and elsewhere. Descriptive brochure.

Kunial Brass. IMPERIAL CHEMICAL INDUSTRIES LTD., Metals Division, Birmingham, 6. Kunial brass is a temper-hardening copper alloy containing 20 per cent. zinc, 6·5 per cent. nickel and 1·75 per cent. aluminium. It is available in strip coils and in flat lengths. Pamphlet of properties, heat treatment and applications.

Gas-Cleaning Plant. HEAD WRIGHTSON IRON AND STEEL WORKS ENGINEERING LTD., Teesdale Iron Works, Thornaby-on-Tees. Research electrical precipitators for cleaning blast-furnace and other gases by the removal of liquid and solid suspended materials. Descriptive publication.

Dust Collectors. W. C. HOLMES & CO. LTD., Turnbridge, Huddersfield. Dust collection and control plant, electrical precipitators, washers, cyclones and filters. Leaflet.

On the Shelf

By Frank H. Smith

I. R. Maxwell and Company, Limited, 4-5 Fitzroy-square, London, W.1, feel that their catalogues are meeting with such success that they are now supplementing them with "Monthly Bulletins." These will deal with specialist subjects and the first—Mathematics Bulletin No. 1—lists recent and forthcoming Pergamon books together with second-hand books and periodicals in stock there on that subject. Looking to see how many items are listed I see that the last is No. 288—*Zentralblatt für Mathematik*, Volumes 1-64, with four volumes still unpublished, at £410. *Does* any library have so much money to spend nowadays?

Butterworth and Company (Publishers), Limited, 88 Kingsway, W.C.2, have brought out a second edition of *Zirconium* in their "Metallurgy of the Rarer Metals" series. The price is 70*s.* Other books in the series are entitled: *Manganese*, *Chromium*, *Titanium*, *Molybdenum* and *Platinum*.

The Machinery Publishing Company, Limited, 21 West-street, Brighton, have produced the 29th edition of their *Buyers' Guide*. Priced at 10*s.* 6*d.* it is one of those desk-side books that receive constant use. He is a happy librarian whose line of country is covered by a good directory.

A new publication in the U.S.S.R. (no address given) is *Atomnaya Energia za Rubezhom*, the purpose of which, it is stated, is to acquaint the Russian public with information concerning achievements in atomic engineering abroad.

The December *Proceedings* of the Institution of Civil Engineers open with "The Telford Story." This is a review of the success of the recent exhibition in the Institution premises at Great George-street, London, S.W.1. The following excerpt rather caught my imagination: "The scene . . . was a transformed reading room lined with 12 ft. high illuminated red screens, forming a vista through which Mr. Leonard Rosoman's floodlit canvas could be seen. This painting, 24 ft. long by 11 ft. 6 in. high, filled the whole of the west wall of the room and featured a dozen of Telford's major works. . . ."

The Institution of Production Engineers include a rather ingenious order form in their latest *Journal*. Their 40 publications are listed with a number alongside. The order form consists essentially of three columns. In the first is the publication number as indicated on the list. The second column is one in which the number of copies required is specified together with the price of each copy, and the third column is for entering the total cost of each number. No elaborate writing of titles is required—just the name, address and the signature on the cheque. The *Journal Supplement* gives particulars of forthcoming meetings and includes the Institution's Conference on "Aircraft Production," held at Southampton on January 2 and 3. I notice, by the way, that more time was planned for discussion. This is a good thing. So often a chairman has to call "Time" just when the body of the hall gets warmed up.

The Royal Swedish Academy of Engineering Sciences sent out, a couple of months ago, specimens of the journal *Acta Polytechnica*. It is now announced that the Scandinavian Delegation for Scientific and Technical Research, P.O. Box 5073, Stockholm 5, Sweden, has re-organised this journal, giving it the name of: *Acta Polytechnica Scandinavica*. It will continue in six sub-series namely, chemistry including metallurgy, civil engineering and building construction, electrical engineering, mathematics and computing machinery, mechanical engineering, and physics including nucleonics. I am afraid that would-be subscribers will have to get in touch with the publishers for the rates, since the literature I have received gives everything else but this.

The National Research Council of Canada, Ottawa, must be pleased with its No. 4200—*Union List of Scientific Serials in Canadian Libraries*. A second printing has been necessary and is available at 25 dols. This does not represent the full publishing cost of the list of 21,000 entries showing the holdings of 140 libraries. Orders should be sent to the Library of the National Research Council.

Unesco announces the publication of the ninth volume of *Study Abroad*, which is obtainable through H.M. Stationery Office, price 12*s.* 6*d.* This valuable work contains particulars of over 75,000 awards offered in 1957/8 by the United Nations and that organisation's specialised agencies.

The Cotton Board Colour Design and Style Centre, 19 York-street, Manchester, 2, have established a Design Library to "provide ever-changing sources of stimulus for producers, textile designers and students." It is quite surprising to learn that such a specialised subject can amass 150 journals and more than 800 volumes. It should be pointed out, perhaps, that the books include works on ferns and botany and birds to help designers of fabrics. Fabric designing must be a fascinating subject. With modern methods of production there seems to be no limit to the designs that can be incorporated and I imagine that the textile manufacturer has some difficulty in curbing the enthusiasm of the young persons who come rushing out of art schools bubbling over with ideas for designs for curtains for bathrooms, nurseries and elsewhere.

Ergonomics is described in the *Chartered Mechanical Engineer* for June, 1957, by Dr. D. F. Galloway, Member of Council, as being the "business of doing more work with less effort." It is interesting to note, therefore, that Taylor and Francis Limited, 18 Red Lion-court, Fleet-street, London, E.C.4, have started with November, 1957, No. 1 of Volume 1 of *Ergonomics: Human Factors in Work, Machine Control and Equipment Design*. This is the official publication of the Ergonomics Research Society. I am delighted to see that abstracts are given at the end of each paper in French and in German. I have waited for a long time to find this reciprocity of a courtesy extended to us by many Continental papers. The price of each number is 25*s.*—£4 15*s.* 0*d.* per volume—post free and payable in advance. The accent, by the way, is on medicine and not operational research.

Research and Development

KEEPING TRACK OF BUSES

Scanning Unit Tells Control Centre Where Vehicles Are

At first sight, finding a bus in a city is not so difficult as finding a needle in a haystack. Buses are conspicuous. But to devise an economical system that will allow a central operator to know the position of each of a fleet of buses calls for considerable ingenuity. The proverbial needle can be quickly picked out, using a magnet. Buses too can be located magnetically; and by television; and by radio communication. Yet when some 7,000 buses are involved, on about 500 routes, such methods become too costly to be practical.

Lack of knowledge where buses are at any instant of time is the main difficulty in operating a regular bus service through congested city streets. To overcome it, London Transport have developed a system that tells them when a particular bus passes selected points on its route. Electronic equipment at each point reads the bus numbers as they pass. Having obtained the number, the equipment transmits it over telephone wires to a central office. There it is displayed on an illuminated panel.

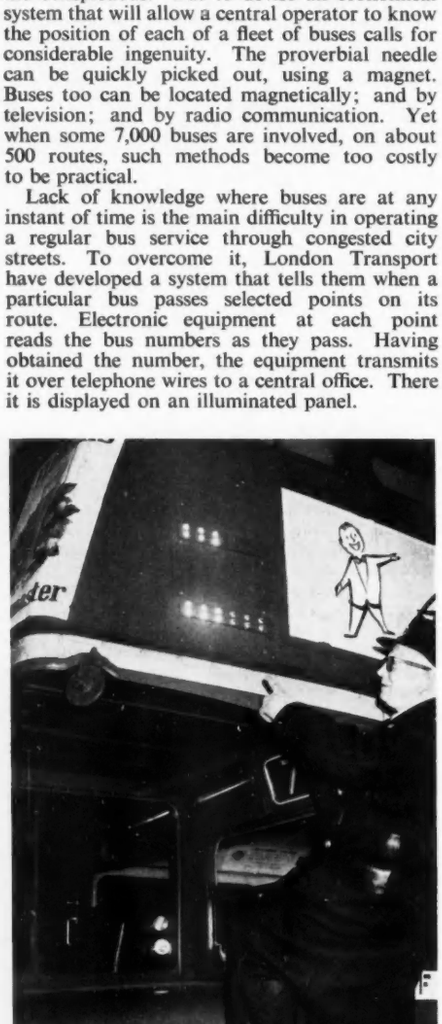

Fig. 1 The identification plate on the bus carries "cats eyes" reflectors. In this view the lower set of reflectors is the timing base.

London Transport will fit reflecting "cats eyes" on the sides of their 7,000 buses. The reflectors serve to identify the bus for the Bus Electronic Scanning Indicator—recently tried out in service on the No. 74 bus route. A variety of schemes were tried, including magnetic scanning and radio communication, but the optical method proved to be best. It is still in the primary development stage but improvements in service are confidently expected from it. Fig. 1 shows the way the cats eyes are fitted.

Each bus running number is put into binary code. This is reproduced on a plate that has a reflector for each digit and a corresponding blank for each zero. The plate fits into slots and is easily changed. It is placed on the nearside of the bus towards the front, above the driver's cab. At selected points on the route, scanning equipment is erected at the same height as the bus plate and as near as possible to the roadway—either on a post at the kerb or, where the pavement is narrow, on a building. The equipment focuses a beam of light on the bus plate and detects the reflected light by a photo-transistor. Each reflector gives rise to a pulse of current through the transistor and the string of reflectors produces a train of pulses as the bus passes the scanner. In fact, the current pulses will be the binary code representation of the bus number.

This way of identifying buses raises several problems. Buses are moving at various speeds, perhaps accelerating, past the check point. The actual height of the identification plate will vary with different passenger loads and positions of the bus on the road camber. Interfering light from external sources will enter the photo-transistor whether a bus is present or not. All these problems call for a solution that is both simple and economic.

To allow for different heights and camber, the reflectors are arranged in pairs, one above the other, at 1 in. centres. To compensate for varying speeds, the plate is produced in two parts. The upper half has a complete row of reflectors that forms a timing base—there is also an additional reflector at the end to act as a clear down unit. The lower half, put 10 in. below the timing base and exactly in line with it, carries the binary code. The horizontal spacing of 2 in. has been found satisfactory for speeds up to at least 40 m.p.h. The reflectors are $\frac{3}{8}$ in. diameter and are designed for a narrow reflecting field. They have very low scatter.

The problem of interference is overcome by giving the light from the scanner an identifying characteristic that will not be present in any other light sources. It is switched on and off 3,000 times a second. The identifying frequency can not be confused with the frequency with which the reflectors return the light as they pass the equipment. For, if the bus is moving at 30 m.p.h., a line of reflectors spaced 2 in. apart horizontally will produce pulses at a rate of 264 c/s—a frequency sufficiently far below 3,000 c/s to avoid confusion. Once the incoming light signals are converted to pulses of electric current by the photo-transistor it is possible to reject all extraneous signals that do not bear the identifying frequency.

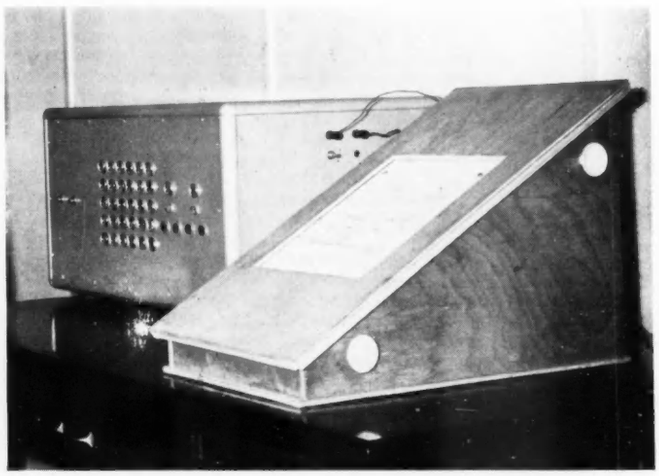

Fig. 2 Each check point on the bus route has a display panel. As a bus passes the check point its number lights up on the panel.

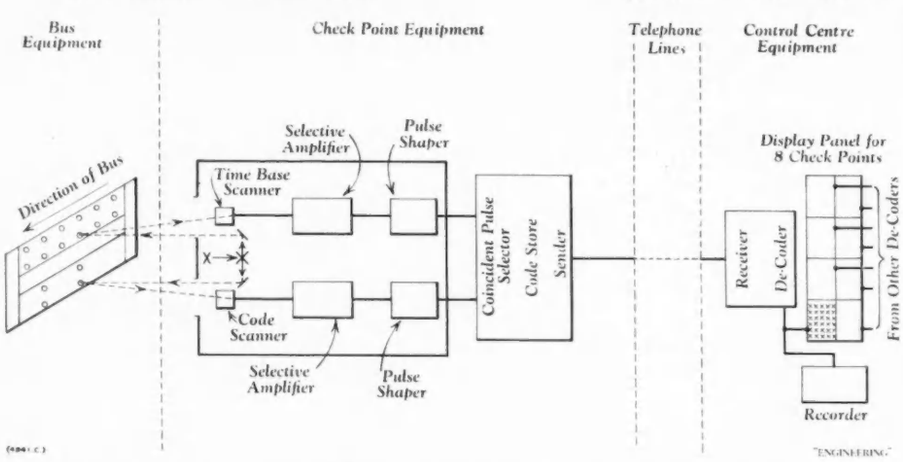

Fig. 3 The general diagram of the Bus Electronic Scanning Indicator, which will allow London Transport to keep track of their buses as they pass through London.

Fig. 2 shows the display panel that is linked to one check point. Each lamp on the panel carries the number of a bus. As a bus passes the check point linked to the panel the corresponding lamp lights. With several panels in the same room it is possible to locate any particular bus by noting the last check point that it passed. The characteristics of the final relays controlling the panel lamps are such that if two lamps are in circuit at the same time, as when a bus passes from one scanning zone to another, the current demand causes the voltage to drop and the light on the first panel is extinguished

in favour of the one on the following panel.

A general diagram of B.E.S.I. is shown in Fig. 3. The telephone lines linking the check point equipment to the control centre will be for the most part London Transport private lines, notably those on their railway system. Otherwise the lines to the scanning points would be the largest financial obstacle to the scheme.

At each check point a scanning equipment must be installed at each side of the road to register the flow of buses. Moreover, the scanner unit must be mounted so that the buses pass within about 12 ft. of it—above this distance the angular displacement of the light becomes increasingly difficult to accommodate. In addition, if the spacing from the kerb becomes too great, there is the danger of a parked lorry completely masking the scanner. Sites chosen, therefore, are places where the road is narrow, or its width restricted due to a pedestrian island. As the scanner unit itself may need to be pole mounted, it has been made as small and as light as possible. When it is mounted in this manner the relays and other equipment must be mounted at suitable positions as near as possible, either in a building or in a street box on the pavement.

Fig. 4 is a diagram of the scanning unit. It will be seen that only one lamp is used and the two beams, for time-base and code number, are obtained by a system of mirrors—shown in Fig. 5. The 3,000 c/s identification is impressed by passing the light through the peripheral slots

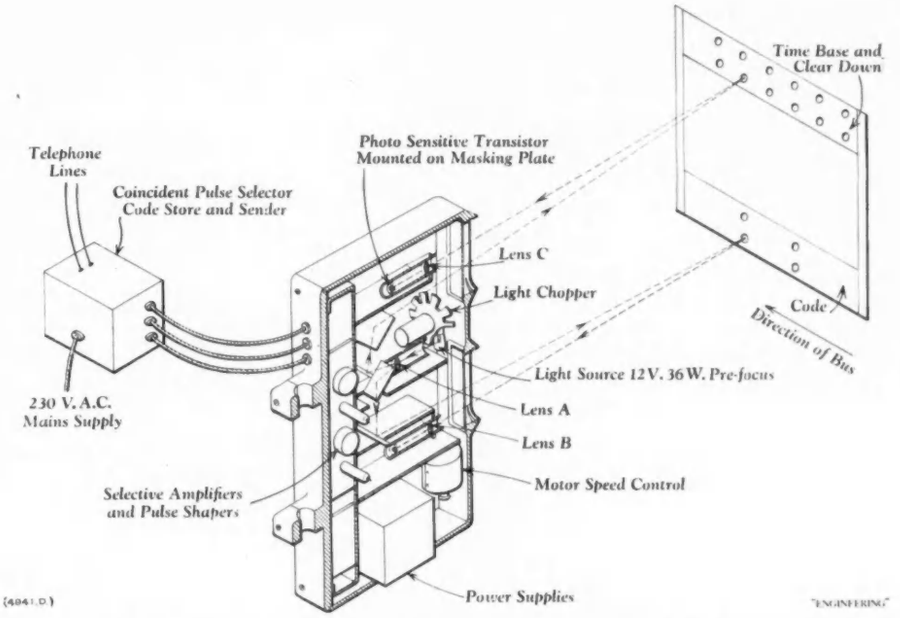

Fig. 4 The scanning unit contains a single lamp whose beam is interrupted by slots on a rotating disc. Mirrors split the beam into two.

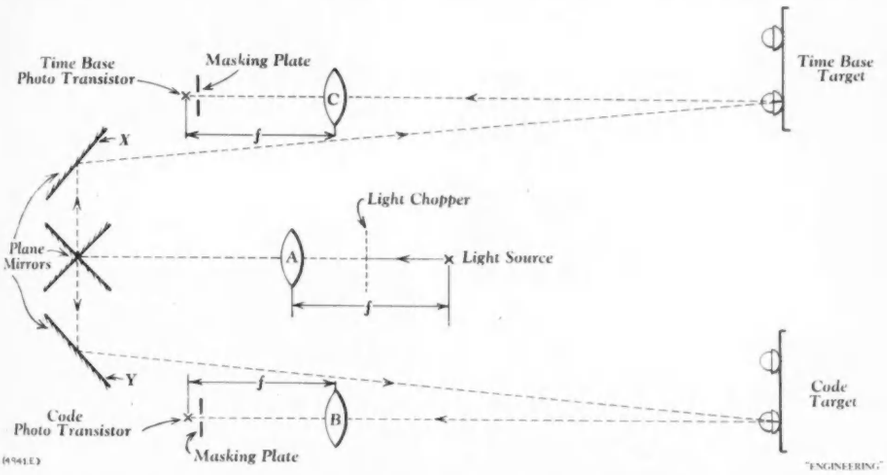

Fig. 5 The simple optical system operates in conjunction with two photo-transistors—one for the code target, the other for the time base.

Fig. 6 The two apertures through which the two beams are projected and reflected back can be seen in this view of an installed unit.

of a rotating disc.

The light reflected from the bus plates is passed into the scanner once more and focused on to two photo-sensitive transistors. These transform the light impulses into electrical impulses. The electrical signals enter frequency selective amplifiers that reject impulses due to extraneous light not associated with that of the instrument's lamp at the controlled frequency. Then, as the waveform of the 3,000 c/s signal impressed with the bus identification code can not operate the telephone relays in the equipment that follows, the signals from the amplifiers are passed through pulse-shaping transformers that give a square pulse from each reflector signal. The pulses from the time-base plate are then paired with those of the code plate by feeding them to cold-cathode valves, and when both time-base and code valves fire together, relays are operated and the code is stored.

Storing is necessary; for at least two scanners—and may be more in busy traffic centres—have to share the telephone line to the control centre. The relays storing the code are released in turn over the line, giving pulses similar to those associated with the dialling of a normal telephone. There is little technical novelty in the circuit used at the control centre. The stored binary number at the scanning point is fed into the line, as soon as a clear channel is available, by normal pulsing procedure.

The pulses are stored in a similar manner by relays at the centre and, when built up, energise the lamp carrying the running number corresponding to the code. In addition, a pen recorder can form a permanent record of the time each bus enters the section and hence indicate the regularity of service. The whole of the equipment has been designed and developed at the London Transport Executive's Electrical Testing Section at Wood-lane, London, W.12, under the direction of Mr. T. S. Pick, the Chief Electrical Engineer.

MEASURING AIR CONTENT OF FLUIDS

Air dissolved or entrained in a hydraulic fluid can be a source of difficulty in operating hydraulic machines. Calibration of flow meters is also affected, and a correction must be made if accurate measurement is required. Investigation of the effect of air content on the performance of hydraulic systems has been difficult in the past because of the lack of a quick and accurate method of measurement.

To overcome this difficulty the Mechanical Engineering Research Laboratory, East Kilbride, Scotland, has developed a simple instrument which enables the total air content of hydraulic oil to be measured in about two minutes. The instrument is made and marketed by F. W. Baggett and Company, Limited, 8 Temple-street, Wolverhampton. In operation a sample of oil of known volume is released suddenly into an evacuated chamber containing steel balls, the large surface of which enables the oil to spread as a thin film, and so to release the air. The total air content is found by measuring the initial and final pressures in the chamber. By measuring the specific gravity of the oil, the proportion of entrained and dissolved air may be found. The instrument has been calibrated with the M.E.R.L. modified Van Slyke apparatus, using fluids with low vapour-pressure which, unlike hydraulic oils, do not froth in the Van Slyke apparatus. There was no significant difference between the values obtained with either apparatus.

Continuing **Research and Development**

LOADING MECHANISM OF INCREASING STIFFNESS

TESTING SPECIMENS OF UNKNOWN STRENGTH

By E. Spencer, M.SC.TECH.*

In many strength testing machines, the load is measured by the deflection of a spring or proving ring. Where the machine is used for testing materials of widely varying strengths, a difficulty arises due to the fact that the strength of the loading mechanism may be very different from that of the specimen under test. The loading mechanism may be unable to supply a big enough force to cause failure in the specimen; alternatively, it may be so much stronger than the specimen that the failure load produces a deflection which is too small to be measured accurately.

In order to extend the range over which a strength testing machine is sensitive a set of interchangeable springs can be used. Alternatively, two springs, or proving rings, can be arranged in such a way that, at small loads, the weaker one acts alone, the other not being brought into action until the deflection of the loading mechanism has reached some predetermined value. Loading mechanisms of this type are shown in Figs. 1 and 2. In the mechanism shown in Fig. 1, the load is carried initially by the outer spring; the inner spring does not begin to share the load until the outer one has deflected by an amount equal to the initial difference in length of the springs. The two proving rings shown in Fig. 2 act in a similar way: the outer and more flexible ring at first carries small loads alone, the inner ring remaining unloaded until the steel cylinder attached beneath it comes into contact with the deflected outer ring.

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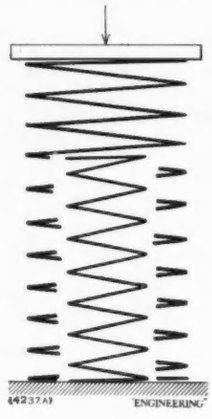

Fig. 1 Coaxial loading springs of different lengths. As with the twin proving rings shown in Fig. 2 this forms a load-measuring device able to cope with specimens of different strengths.

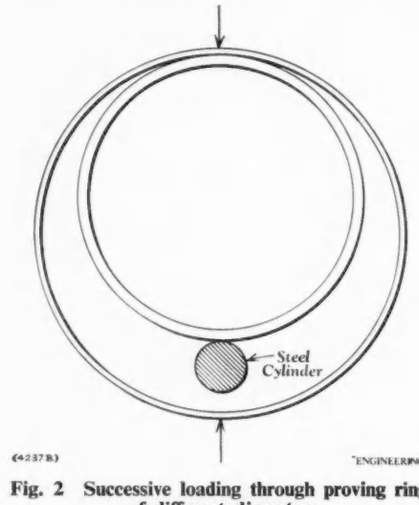

Fig. 2 Successive loading through proving rings of different diameters.

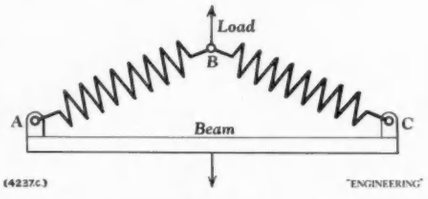

Fig. 3 Diagram of author's method of loading through sloping springs. This arrangement gives a gradually increasing stiffness well suited for materials testing, particularly soils.

The inconvenience of frequent changes of spring is not the only disadvantage of using a set of interchangeable springs: unless the strength of the specimen can be assessed fairly accurately before the test is begun, the spring chosen for the test may be unsuitable for the reasons given in the first paragraph. The extended range of the mechanisms shown in Figs. 1 and 2 is a highly desirable feature in a machine used for testing specimens of widely different strengths but both suffer from the disadvantage that the change in stiffness is sudden and might cause premature failure of the specimen. On the other hand, the stiffness of the loading in the case of the machine described below changes gradually, increasing as the resistance of the specimen increases. It can be made strong enough to test to failure any specimen likely to be encountered, but its deflection at small loads will always be sufficient to permit accurate measurement.

The mechanism consists of two springs acting together as shown in Fig. 3. The springs, which are of equal length and stiffness, are joined together end to end, the outside ends being attached to a beam. Initially, the springs are at right angles to the applied load and their effective combined stiffness is zero. As the load increases, the springs pivot at A, B and C, joint B rises and the slope of the springs increases. As the slope increases, the stiffness of the loading mechanism increases. The load-deflection curve for this device is shown in curve II of Fig. 4; curve I shows the curve for an axially-loaded spring. As curve II shows, the stiffness of a pair of springs operating in this fashion increases gradually from zero (if the springs are initially horizontal) to a value approaching double the axial stiffness of one of the springs acting alone. If a load-deflection curve intermediate between the extremes of I and II is required, as indicated by curve III, this can easily be obtained by giving the springs a small initial slope. The advantage of this is that the total deflection of the loading mechanism is reduced.

The maximum load P which each of the springs must be capable of carrying and their stiffness s are given by the following expressions:

$$P = \frac{W}{2}\sqrt{1 + \frac{L^2 - h_0^2}{d^2}} \text{ lb.}$$

$$s = \frac{P}{\sqrt{d^2 + L^2 - h_0^2} - L} \text{ lb. per in.}$$

In these expressions:

- W = the maximum load in pounds which the mechanism is required to supply.
- L = the initial overall length in inches of each spring.
- d = the height in inches to which joint B rises above the level of joints A and C.
- h_0 = the initial height in inches of joint B above the level of A and C. h_0 will of course be zero if the springs are initially horizontal.

The derivations of these two formulae are given later in the article.

Calibration.—Once the values of P, L and h_0 have been settled, a load-deflection curve can be obtained by substituting in the first of the above formulae increasing values of d and calculating the corresponding values of W. Alternatively, the load-deflection curve can be found experimentally by inserting a spring of known stiffness in the place normally occupied by the specimen under test and plotting the deflection of this spring against that of the loading mechanism. If the scale of deflection of the test spring is then multiplied by the stiffness of this spring, a load-deflection graph for the loading mechanism will be obtained.

Application.—This type of loading mechanism has been applied to the unconfined compression machine developed at the Building Research Station by Cooling and Golder for testing cohesive soils. This machine was originally supplied with a set of three springs but was fitted with the loading mechanism described above in order to avoid the necessity of choosing the most suitable spring for any given specimen. It has worked entirely satisfactorily and can be relied upon to give results at least as accurate as those from the original set of springs and with a considerable saving of time when a large number of specimens of widely differing strength

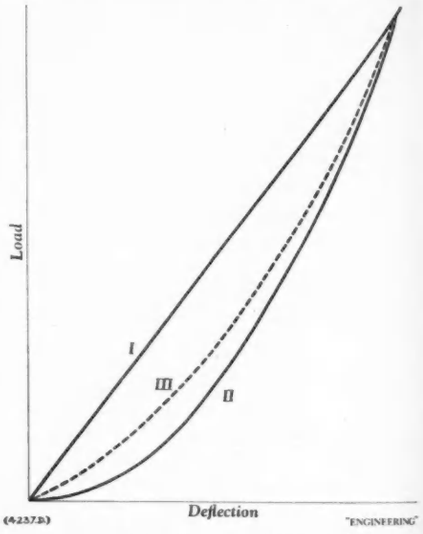

Fig. 4 Load-deflection curves for loading through axial and sloping springs.

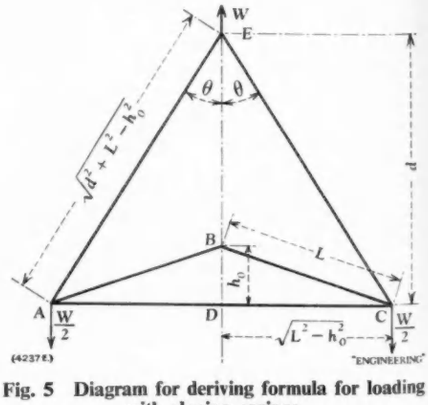

Fig. 5 Diagram for deriving formula for loading with sloping springs.

have been tested. The machine in its original and modified forms is shown in Figs. 6 and 7.

Derivation.—In Fig. 5, A B and B C represent the overall length L, of the springs before loading. A E and E C represent the overall length of the springs when the mechanism is subjected to a load W lb. A C represents the span of the beam carrying the springs and the initial slope of the springs is

$$\frac{2h_0}{AC} = \frac{h_0}{DC}.$$

Now

$$DC = \sqrt{L^2 - h_0^2}$$

and

$$EC = \sqrt{d^2 + DC^2} = \sqrt{d^2 + L^2 - h_0^2}.$$

When the load on the mechanism = W lb., the load carried by each spring is given by

$$P = \frac{W}{2\cos\theta} = \frac{W \cdot EC}{2ED}$$

$$= \frac{W}{2}\frac{\sqrt{d^2 + L^2 - h_0^2}}{d}$$

$$= \frac{W}{2}\sqrt{1 + \frac{L^2 - h_0^2}{d^2}} \text{ lb.}$$

Now the extension of each spring under the load P lb. is

$$EC - BC$$

$$= \sqrt{d^2 + L^2 - h_0^2} - L$$

Therefore, the stiffness of each spring is

$$s = \frac{P}{\sqrt{d^2 + L^2 - h_0^2} - L} \text{ lb. per in.}$$

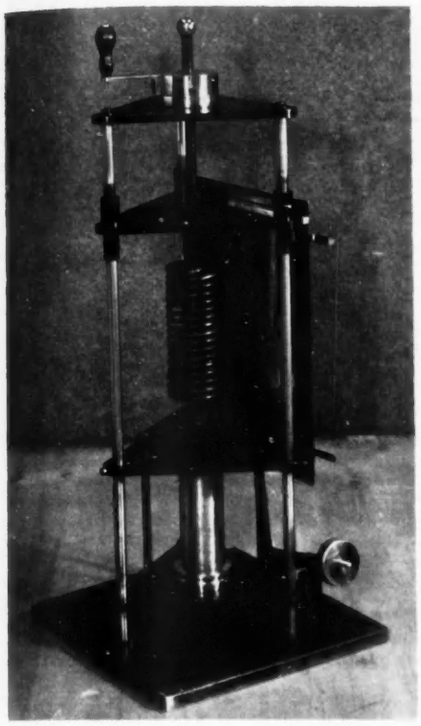

Fig. 6 Testing machine for soil mechanics laboratory in its original form.

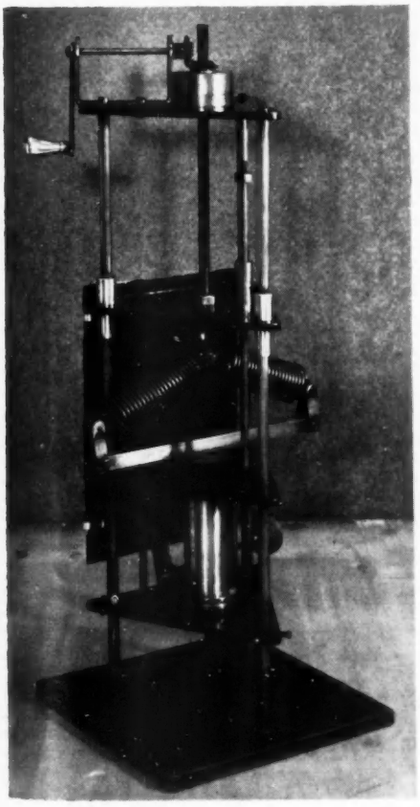

Fig. 7 Author's loading device applied to machine shown in Fig. 6.

TURBINE-POWERED HELICOPTER RIG

Engines, transmission and rotor-head for helicopters are tested in this suspended fuselage.

A turbine-powered helicopter ground rig, in the twin-engine tandem-rotor configuration, has now begun preliminary running tests at Bristol Aircraft Limited's helicopter centre at Weston-super-Mare. The rig, which is powered by two Napier Gazelle free-turbine engines each developing 1,650 s.h.p., is the first of two that have been built to develop and test the engines, transmission and rotor-head systems which will be used on production versions of the Bristol type 192 helicopter. Virtually a complete airframe, the rig is capable of simulating, under test, gearbox, transmission and steady-flight loads closely akin to those which will be actually experienced during flight.

For test purposes, the rig is suspended from a gantry assembled from standard Bailey bridge components; the gantry is fitted with a noise-reducing baffle developed by the company in conjunction with the National Physical Laboratory. Following the initial tests, the rig will be subjected to intensive periods of endurance running, in order to establish the high standard of reliability required of the various systems before the type 192 goes into service. Whereas the first rig is operated from the cabin, the second will be operated entirely by remote control from a control caravan on the rig site, which will greatly facilitate testing over long periods of continuous running.

Many of the problems normally encountered during the early flight test period—such as engine control, satisfactory functioning of transmission, lubrication and cooling systems—can be solved by the use of equipment of this type, and a further rig is nearing completion for the structural and dynamic testing of controls.

The Gazelle-powered type 192, which is now in production for the Royal Air Force, is a direct development from the Bristol type 173 research aircraft, the first twin-engine tandem-rotor helicopter ever to fly.

SOVIET ELECTRICAL LITERATURE

Journal to be Published in English

Electrical Engineering U.S.S.R., an English translation of the most important papers in the Russian journal *Elektrichestvo*, is to be published by Pergamon Press on behalf of the Pergamon Institute, a non-profit-making foundation formed for the furtherance and dissemination of scientific knowledge. By arrangement with the Ministry of Electrical Power Stations of the U.S.S.R. and the publishers of *Elektrichestvo*, rush copies and original illustrations are to be forwarded to the Pergamon Institute. Its articles cover technical and economic aspects of power supply systems, the design and application of electrical machines, switchgear and measuring instruments as well as papers on broader topics such as automatic control and the analysis of fields and networks. *Electrical Engineering, U.S.S.R.* will be published under the supervision of an International Advisory Board of electrical engineers and scientists.

Design

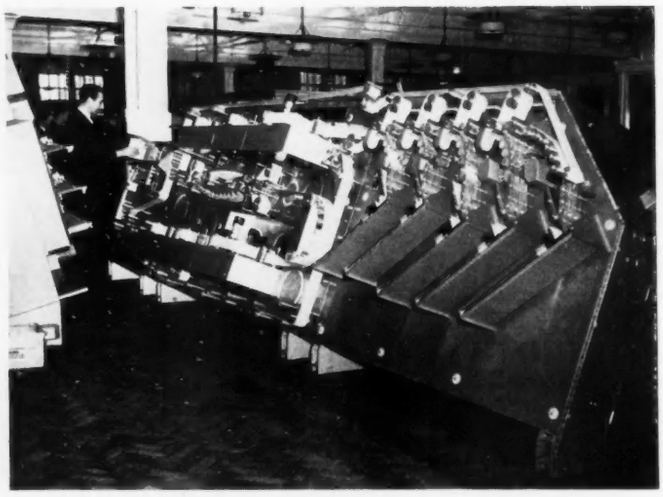

Fig. 1 A machine has been designed to turn unsorted letters the same way. They are cancelled and stacked at the rate of 300 per minute.

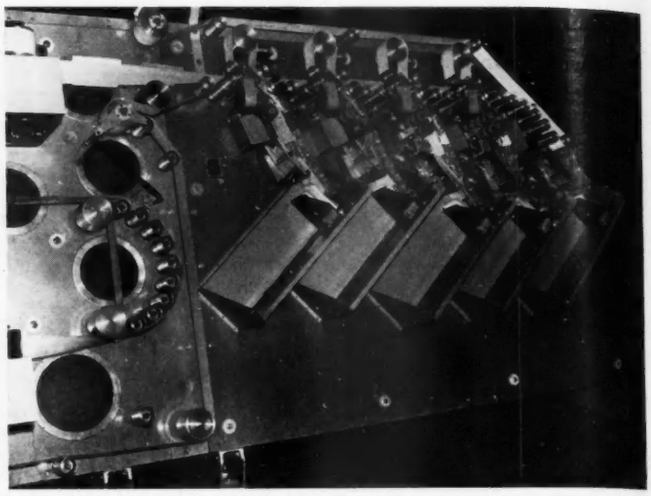

Fig. 2 Five stacks of letters are made, normal, pre-paid at a lower rate, both with stamps facing upward or downward, and with no stamp detected.

POST OFFICE MECHANISATION

LETTER FACING MACHINE BEGINS FIELD TRIALS

The field trials of a machine designed to perform the tedious task of "facing" letters (that is, taking them from a random pile and turning them all the same way up) began at Southampton on December 19 last. The machine was developed in the Dollis Hill laboratory of the Post Office and represents the fruition of work begun in 1937 but which had to be suspended during the war.

The machine does its job by searching for the stamps on the letters as they pass through it, re-arranging the envelopes as necessary, and stacking them in orderly piles. Included in it is a date-stamping unit, so that the letters emerge not only the right way up but also post-marked, ready for sorting. The machine discriminates between ordinary (fully-paid) letters, and printed papers (i.e., unsealed envelopes with a 2*d.* stamp on them and containing such things as circulars, notices, receipts and invoices). The latter are picked out by the machine and stacked separately so that they can be dealt with apart from the fully-paid letters.

Initially, a detailed study to select the best method of recognising stamps was undertaken. The obvious choice seemed to be the use of photo-electric cells which would not only pick out the stamp against the background colour of its envelope, but could also differentiate between various colours, thereby enabling the lower-paid printed paper matter to be segregated for separate treatment. Unfortunately, this method proved to be inadequate for practical purposes.

Research was then concentrated on the possibility of endowing the stamps with some special characteristic which could be detected unerringly by the scanning unit incorporated in the machine. Many lines of approach were tried—among them, the incorporation of strips of metallic foil; treating the stamp paper with zinc or aluminium paper; impregnating it with a solution of salt (for electrolytic detection) or ferric oxide (for magnetic detection)—but all had to be ruled out on one ground or another. Then, in 1956, the first experiments with "graphite inks," which could be printed in lines on the stamp paper during the manufacturing process, started and were sufficiently encouraging for intensive studies to be made of this technique.* In collaboration with Harrison and Sons, Limited and Acheson Colloids, Limited (the makers of "Dag" colloidal graphite), the substance used for the present trials was evolved.

During the laboratory experiments the substance was called "naphthadag," as naphtha was the principal liquid used to hold the graphite in suspension for printing; more recent research has, however, yielded other liquids with better printing qualities. Stamps of the 2*d.* value are printed with one graphite line, on the back of the paper under the gum, and those of other denominations (up to 3*d.*) are printed with two. The lines are black and $\frac{1}{32}$ in. wide; they act as electrical conductors so that when letters carrying these stamps pass through a high-voltage scanner the current passes through the stamp, completes an electrical circuit via the lines, and causes a recognition signal to be given. A single 2*d.* stamp gives one signal; any other stamp or combination of stamps gives at least two, which is sufficient for the machine to distinguish between the lower-paid matter and the rest.

The present machine, shown as a whole in Fig. 1 and the stacking section in Fig. 2, is designed to handle "short" letters (i.e., those up to about 5 in. by 7 in. in size) at a rate of over 300 a minute. It measures 20 ft. long, 6 ft. tall and 5 ft. wide, and consists of three main sections: (1) the feed section, (2) the scanning section, and (3) the stacking and cancelling section.

In Fig. 1 a bundle of letters is being put into the feed section, the purpose of which is to produce a stream of separated letters. The belts carry these downwards into the scanning unit, where, held between two belts, they pass on edge in front of the first scanning head, which observes the bottom edge of the letters. All letters pass along the centre line of belting, but if no stamp has been detected by the first scanning head, they are diverted into the upper stream where the belting is so arranged as to turn them through 180 deg. before they rejoin the main stream (at the far end in the illustration).

The letters are now carried up to the third portion of the scanning section and when they are turned on edge by the belts to pass before the second scanning head, all stamps should now be at the bottom. However, some will be on the leading edge (letter facing inwards) and some on the trailing edge (letter facing outwards) and these positions are detected by the scanner so that the letter is diverted to the appropriate stacking tray. At the same time, the scanner detects whether the letter is paid at the lower rate, and again selects the proper stack.

The stacking section, the last part of the machine, is shown in detail in Fig. 2. There are two stacks for 2*d.* rate letters and two for full rate, while a fifth is provided for those letters on which no stamp has been detected. On the first four channels, the cancellation rollers are arranged to suit the stamp position (that is, facing upwards or downwards) but no cancellation is provided for the suspects.

Although the initial laboratory trials have given promising results, much work remains to be done. In particular, research will continue to try to devise a method of treating stamps which does not involve a visible marking. The graphite lines used for the present experiment have been adopted in order to give the machine the earliest possible trials under live traffic conditions, and it does not necessarily follow that stamps will be permanently treated in this way.

Other work will be directed towards devising an automatic transfer system between the segregating machine—which is also currently undergoing trial at Southampton—and the facing machine, and at a later stage between the facing machine and the sorting machine, with the ultimate aim of achieving a system whereby letters need not be touched by hand at any point of their journey through the sorting office. (The segregating and sorting machines were described in a previous article, page 694 in the issue of May 31, 1957.)

* ENGINEERING, page 408, September 27, 1957.

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DRAFTING TABLE

In most drawing offices the draughtsman has a reference table on which drawings can be laid for consultation. One such has now been made by E. N. Mason and Sons, Limited, Arclight Works, Colchester, which is made of hard wood and is available in two sizes, double elephant and antiquarian. Each unit carries a sliding reference top mounted on runners, which can be extended to a distance of 12 in. This top is constructed at a slight incline and is fitted with a ledge along the front. The tables are designed so that they can be fitted with a table type drafting stand and any size of board. They contain one long drawer and two short ones, a pull-out tray, on which drawing instruments or the afternoon cup of tea can be placed, and a book shelf for volumes of reference below the long drawer. The overall dimensions are, for the antiquarian, 60½ in. wide, 37½ in. deep from front to back and 33 in. high.

BOATS FOR THE PRIVATE OWNER

The fourth national Boat Show organised by the Ship and Boat Builders' National Federation and sponsored by the *Daily Express* opened at Olympia on January 1. Such a plethora of worthwhile exhibits was on display that the prospective small boat owner found a single day hardly sufficient to review all the possibilities open to him. As usual, there was ample evidence to show that true craftsmanship was not lacking in this country, while the engine exhibits indicated a most substantial background of technical know-how. Well over 200 firms were represented, and the craft shown on the stands ranged from tiny dinghies up to the 48 ft. pilot launch "Corsair" built by the Rowhedge Iron Works Company. Elsewhere one found luxury motor cruisers, sailing yachts for ocean racing and cruising, hydroplanes, powered runabouts, outboard engines, water scooters and a variety of fittings for every conceivable purpose.

Even a cursory glance at the numerous exhibits served to emphasise the ever increasing use made of glass-fibre reinforced plastics as a construction medium for the hulls of a wide variety of types of craft. The latest large firm to enter this field is John I. Thorneycroft who showed a cabin cruiser, while the Samuel White Group were showing a number of such hulls. Halmatic, also well known for their "Deborine" construction, showed how they were proposing to reduce fitting out costs by increased use of plastics.

Fairey Marine, using a different constructional technique and medium, have produced in the past a most successful range of sailing hulls hot-moulded from wood veneers. Their latest product, using this method of manufacture is the "Carefree"—a high-speed motor boat.

A large number of firms cater for those who are interested in smaller boats, and here one noteworthy feature is that a high proportion of them are willing to supply their designs in kit form for home assembly. Surprisingly few catamarans were on show in spite of their obvious hydrodynamic advantages and development potential (*vide* "The Motion of a Yacht through Air and Water," ENGINEERING last week). The "Shearwater III" and the "Jumpahead" were two shown on the stands of G. Prout and Air Service Training, respectively. The Shearwater in particular has been developed over some years and it is claimed with every justification that it represents the fastest light sailing class to-day. At the other end of the speed range are the floating caravans or mobile houseboats. These have been popular in America for some time and will undoubtedly appeal to many who fancy slow river cruising in comfort.

In the engine field it was most satisfying to find that Coventry Climax are now producing an outboard motor of considerable power. So far, the Americans have been almost undisputed in their command of the large outboard motor field and British firms have no doubt realised the considerable export possibilities.

In spite of the excellence of so many of the exhibits, the fourth Boat Show—taken as a whole—was just a little disappointing. Some of the exhibits too closely resembled those of last year, and there was not enough evidence of enterprise designed to tap the hitherto unreached market composed of people who perhaps know little of the sea but are appreciative of the modern streamlined appearance associated with contemporary cars design. In this respect the 16 ft. Aqua Craft "Avenger" shown on the Burnham Motor Boat stand was encouraging and some of the other craft in the same family had a particularly attractive "transatlantic" appearance.

There were of course some exhibits which might well point the way to important technical developments in the near future. The Amateur Yacht Research Society were showing experimental hydrofoil stabilisers, while as an example of the result of extensive development tests in their own towing tank Saunders-Roe exhibited a radio-controlled scale model of a 17 ton hydrofoil craft capable of high speeds in rough seas.

There is little doubt that the market for even quite small craft will become more and more competitive even though this market is rapidly expanding. Small firms may well have to combine in order to adopt mass production techniques. Furthermore, scientific approach to design will become more and more necessary to obtain maximum efficiency in order to compete with the products of other firms. Future Boat Shows will undoubtedly demonstrate how British firms meet the challenge of economic mass production and scientific design. It is to be hoped that they will also not only demonstrate once again the quality of British products but also a flair for imaginative superstructure design suited to the aesthetic taste of a much wider market.

CIVIL ENGINEERING SLIDE-CHART

The two illustrations above show the front and reverse sides of a "slide-chart" that has been designed to facilitate certain calculations common in civil engineering—those for reinforced concrete beams and for water flow in pipes or over weirs. One side of the chart—which is used as a slide-rule—is devoted to the hydraulics, the other to reinforced concrete. It has been designed by Mr. W. E. Blackmore, M.I.C.E., and it is made and distributed (price 22*s.* 6*d.*) by Kosine Limited, 104 High Holborn, London, W.C.1.

The reinforced concrete scales are based on a theory modified slightly from the conventional or "classical" theory, one of the fixed scales giving the moment of resistance for nominal stresses of 800 lb. per sq. in. and 18,000 lb. per sq. in. for the concrete and steel respectively; a value of 15 is used for the modular ratio, *m*. Use of the scales enables bending moments, effective depths, actual stresses and steel areas (both in tension and compression) to be calculated, all in terms of a 12 in. width of the beam or slab. A convenient table on the face of the chart gives steel areas and weights per foot run in terms of bar diameter and spacing.

On the reverse side there are three hydraulic scales: for flow in circular pipes, based on the use of Manning's formula; flow over rectangular weirs; and flow over triangular notches. The second and third of these scales are easily operated to relate flow in terms of the effective head. For pipe flow, using Manning's formula, two related sets of scales are used, one of which incorporates the coefficient of roughness. The scale is graduated from 0·003 to 0·27 and typical surface coefficients are also named, for example, "rough concrete" (0·017) and "smooth-coated steel and cast iron" (0·012).

The general accuracy of the slide would seem to be of the order of that obtained with a 5 in. slide-rule. The great value of such rules is found, however, not in problems where there is a well-defined group of known quantities and one unknown to be determined, but where a number of independent quantities have to be found that are mutually consistent.

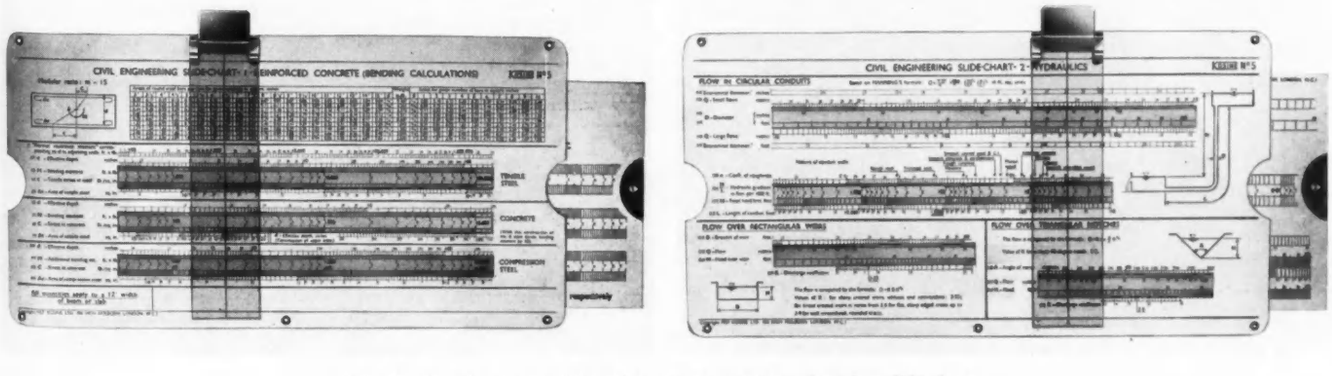
MARINE GAS TURBINES

Fast Patrol Boat Launched

The first of the new Brave Class fast patrol boats (medium), H.M.S. Brave Borderer, was launched on January 7, 1958, at the Portchester yard of Vosper Limited, who constructed and fitted her out. The length of the new boats is 98 ft. 10 in. (extreme) and 90 ft. between perpendiculars. The beam is 25 ft. 5½ in.

The craft is powered with Proteus gas turbines, adapted for the Royal Navy by Bristol Aero Engines Limited, in association with W. H. Allen Sons and Company, who supplied the primary reduction gears and the reverse reduction gearboxes. The present authorised maximum rating of the marine Proteus is 3,500 s.h.p. and the maximum continuous rating 2,800 s.h.p. Including the reverse reduction gearbox, the weight to power ratio of the installation is 1·6 lb. per h.p. In addition to the Proteus engines, Rover gas turbines driving Metropolitan-Vickers 40 kW generators, provide electrical power.

The armament of a Brave Class vessel operating as a motor gun boat will consist of one 3·3 in. calibre turret-mounted gun specially developed and fitted with a stabilisation system capable of dealing with the severe motion experienced. There will also be one 40 mm. single-barrelled mounting (Bofors) and two 21 in. torpedoes. Where these craft operate in the motor torpedo boat role the armament will be four 21 in. torpedoes and one 40 mm. Bofors. The complement will be three officers and 17 ratings with the addition of two ratings for the senior officer's ship of a squadron. Fast patrol boats are designed for offensive operations particularly in coastal and shoal waters.



The front and reverse sides of the Kosine civil engineering slide-chart.

Engineering at Home

BACK GARDEN BEAM AERIAL

THE LAW restricts amateur radio enthusiasts to output powers that, compared with normal broadcasting stations, are very low. Thus to gain the maximum efficiency out of their equipment it is essential for them to ensure that no power is wasted. As far as the aerial system is concerned this criterion can be met by beaming the transmitted signal in the direction of the station being worked. An efficient beam aerial gives an effective power many times that obtained with a simple omni-directional aerial. The same advantage is enjoyed when a beam aerial is used for reception.

Most simple beam aerials function at one frequency only. This is a disadvantage when operation on several different frequencies is anticipated. A familiar example of the inconvenience that this can cause is provided by the widespread use of two aerial systems for television reception —one for the I.T.A. and one for the B.B.C. Recent developments have led to the production of single aerial systems that provide directional reception for both programmes. In a similar fashion the Panda Radio Company, Limited, Rochdale, Lancashire, have produced a beam aerial for amateur radio enthusiasts that operates on three wavebands—10, 15 and 20 metres. Fig. 1 shows the complete aerial. Fig. 2 shows the aerial in knock-down condition.

In designing the aerial, particular attention was directed to keeping the weight and size as small as possible to permit its use even in a very small back garden. It is claimed that the aerial is easily erected and needs no elaborate supporting tower. A single feed line to the aerial is used on all three bands and no adjustment to the aerial is required when changing from band to band.

To make the aerial suitable for a wide range of climatic conditions in various parts of the world, high-tensile aluminium alloys—supplied by the Northern Aluminium Company, Limited, Banbury, Oxfordshire—are used for the "Globemaster Minibeam," as the aerial is called. Noral 51 SWP tubing makes up the boom and elements and Noral 350W the clamps. The complete array weighs 35 lb. and the makers claim that it can withstand the worst weather conditions.

The beam consists of three basic elements—a driven element, a director, and a reflector. The elements are split at the centre. The method used to get three-band resonance is a system of inductive loading with electronic switching by means of quarter-wave stubs. The design of the director illustrates the principles involved.

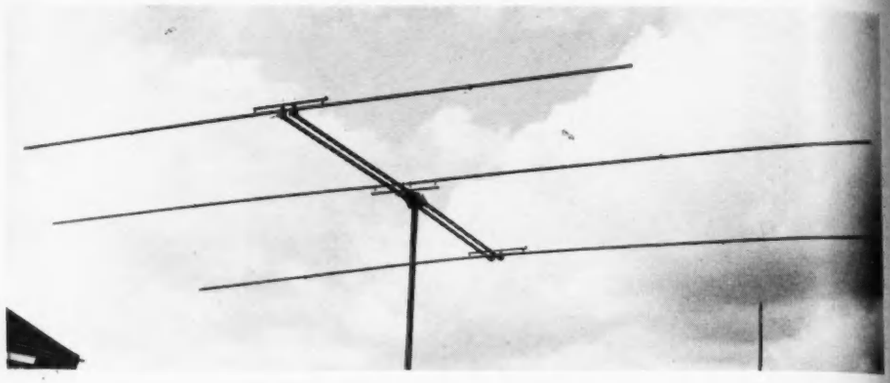


Fig. 1 (above) The Globemaster Minibeam aerial gives beamed transmission and reception on three wavebands without switching or tuning.

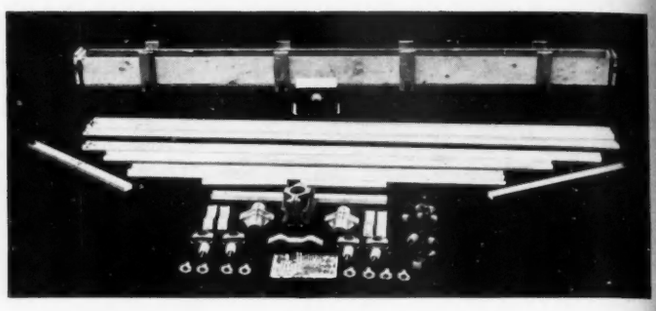


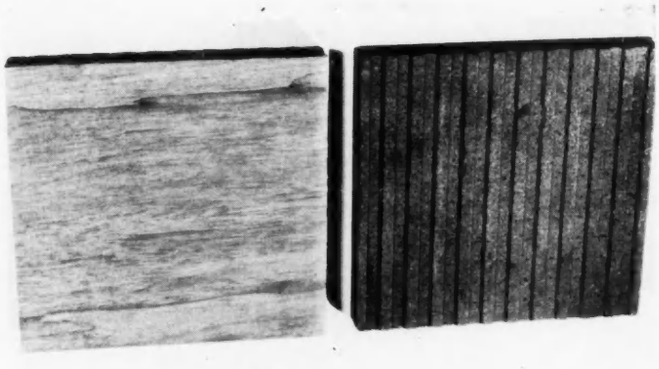
Fig. 2 (right) The complete array weighs 35 lb. Here it is shown as supplied in knock-down condition.

A change in the resonant frequency of a parasitic element can be made by altering its dimensions or by inserting a reactance at the centre of the element. Inductance will lower the resonant frequency: capacitance will raise it. In the Minibeam the director is 16 ft. long and is loaded with an inductor at the centre. Across it a piece of twin feeder cut to be resonant in the quarter wave mode at 10 metres is connected with its far end open circuit.

At 10 metres the feeder forms a short circuit and the director resonates by virtue of its length. At 15 metres the feeder forms an open circuit and the director-inductor combination will resonate. Thus two-band resonance is obtained for the director. A somewhat similar approach is used for the reflector, which is 23 ft. long. It resonates in combination with its inductor at 20 metres, and, without it, at 15. The driven element is 24 ft. long and operates in conjunction with an automatic matching unit.

On 10 metres the beam becomes a five-element array and gives more gain and greater bandwidth than could be obtained with five elements in line. On 15 metres the array is a normal three element Yagi except that the radiation resistance and gain are somewhat higher than normal due to the extended driven element. On 20 metres the beam is a two element array with shortened elements.

The gain on 10 metres is 9·5 db., on 15 metres 7·5 db., and on 20 metres 4·5 db. over a simple dipole. The front-to-back ratio is 20-30 db. To the transmitting amateur in the United Kingdom, restricted to a power input of 150 watts, the use of the beam gives an equivalent power of 1,350 watts on 10 metres, 840 watts on 15 metres, and 420 watts on 20 metres.



COMPOSITE TILES

Tiles 9 in. square consisting of a hard wood surface with a resin bonded sand base are being made by British Plaster Board (Manufacturing) Limited, 82 Piccadilly, London, W.1. Views of the back and front of the tiles are shown in the illustration. Referred to as "Blue Hawk" flooring, the tiles can be laid on a cement mortar bed without the usual finishing screed. The company claim that the tiles combine the decorative qualities of wood with resistance to movement, moisture, dry rot, and that they will not support combustion.

ENGINEERING

Published every Friday by ENGINEERING LTD. at 36 Bedford-street, London, W.C.2.
Telephone: Temple Bar 3663.
Telegrams: Engineering Lesquare London.

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